LAKE ONTARIO FISHERIES UNIT

1987 ANNUAL REPORT

Ontario
Ministry of
Natural
Resources

1987 ANNUAL REPORT

LAKE ONTARIO FISHERIES UNIT

to the

GREAT LAKES FISHERY COMMISSION'S
LAKE ONTARIO COMMITTEE

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**ASSESSMENT AND RESEARCH PROGRAMS
CONDUCTED BY THE
LAKE ONTARIO FISHERIES UNIT
BETWEEN APRIL 1, 1987 AND APRIL 1 1988.**

A. COMMERCIAL FISH HARVEST ASSESSMENT PROGRAM
- Project A1: Index gillnetting
- Project A2: Commercial fish sampling
- Project A3: Incidental commercial catch sampling

B. WALLEYE STOCK ASSESSMENT PROGRAM
- Project B1: Spring tagging
- Project B2: Fall tagging
- Project B3: Summer creel census
- Project B4: Winter creel census, Jan-Feb, 1988

C. LAKE WHITEFISH STOCK ASSESSMENT PROGRAM
- Project C1: Spring tagging at Athol Bay
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D. LAMPREY MONITORING PROGRAM
- Project D1: Coho egg taking
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E. SALMONID ASSESSMENT PROGRAM
- Project E1: Coho egg taking (same as D1 above)
- Project E2: Harvest surveys
  - a) trailer counts
  - b) eastern Lake Ontario harvest survey
  - c) western Lake Ontario harvest survey
  - d) charter boat questionnaire
- Project E3: Lake trout Assessment
  - a) adult lake trout assessment (DEC/FWS/OMNR)
  - b) smelt trawling (DEC/FWS/OMNR)
  - c) harvest assessment (same as A2, A3, and E2 above)

F. RESEARCH PROGRAM
- Bay of Quinte gillnet and trawl series
- Trophic studies
- Fish species studies
- Lake Ontario Studies
- Bay of Quinte Remedial Action Plan
- Alewife diet
- Lake trout spawning shoal studies

G. SPECIAL PROGRAM AND ACTIVITIES
- Community oriented lake assessment (COLA)
- Review of the assessment activities

Great Lakes Fisheries Commission
Lake Ontario Committee Meeting
March 8-9, 1988

WALLEYE POPULATIONS IN EASTERN LAKE ONTARIO AND THE BAY OF QUINTE, 1987

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ABSTRACT

The population of 3-year-old and older walleye in eastern Lake Ontario during spring 1987 has been estimated at 588,000 using age specific Jolly-Seber mark/recapture methods. This was down 29% from spring 1986 because of poor recruitment from the 1984 year class. Research trawls indicated strong year classes for 1985, 1986, and 1987. In particular, indications were that the 1986 year class will be larger than than any other year class in the last two decades. Accordingly, populations should increase when these year classes are recruited. Considering such high variability in year class strength, we should expect year to year variability in angler success to be a normal part of the fishery.

RECOMMENDATIONS

1. Perform mark/recapture sessions directed at eastern Lake Ontario walleye once each year during fall to improve our coverage of younger age classes and avoid potential bias associated with spring sessions.

2. Develop relationship between young-of-year and 3-year-old walleye of the same year class in eastern Lake Ontario to predict populations before they are recruited.

3. Use a cohort model to predict the effect of optional management strategies on the populations and age structure of walleye in eastern Lake Ontario.

4. Develop a recruitment model that combines stock recruitment relationships with environmental influences for eastern Lake Ontario walleye.

INTRODUCTION

Most walleye (*Stizostedion vitreum*) in Lake Ontario are associated with the Bay of Quinte because of suitable habitat for all life stages, and because major spawning areas of Lake Ontario walleye are rivers that flow into the Bay (Trent R., Moira R., Salmon R., Napanee R.). Also, walleye may spawn on shoals and in several smaller streams around the lake. However, the contribution of walleye from these shoals and smaller streams to the total lake population is, for the most part, poorly known. Moreover, walleye tagged in the Bay of Quinte are caught in Lake Ontario and visa versa. Based on these tag returns we now treat eastern Lake Ontario and Bay of Quinte walleye as one large population with several components formed by the stocks that spawn in various streams. Other smaller stocks of walleye are located around the perimeter of the lake where habitat is suitable, for instance, at the mouth of

the Niagara River, and some of the other rivers entering the lake.

In this report we describe the status of the walleye population in eastern Lake Ontario and the Bay of Quinte. Walleye populations in the Bay of Quinte crashed in the 1960s, associated with excessive eutrophication in conjunction with overexploitation (Hurley and Christie, 1977). However, after improvements in domestic sewage treatment which reduced eutrophication and a massive winterkill of white perch (*Morone americana*), a strong year class of walleye in 1978 and later another strong year class in 1982 occurred. Together these year classes have dominated the commercial and angler harvests through most of the 1980s, and have been influential in the further recovery of walleye populations. (There has been no commercial allocation for walleye harvest since 1984.) This report will be based almost exclusively on post-1978 year classes.

MARK/RECAPTURE PROGRAMS

Two mark/recapture sessions were conducted during 1987. The spring session lasted from April to June, and the fall session lasted from September until November. Walleye were captured in trapnets and marked with fin ray punches unique for each session and net location. The sampling locations were located throughout the Bay of Quinte, in Athol Bay, and outside Wellers Bay. In general, we followed the methods that were used in previous years (Malone, 1986; 1987). A complete description of the methods and sampling locations are found in Bowlby (1988a).

POPULATION SIZE

Walleye populations were estimated by stratifying the population by year class and applying the Jolly-Seber model to each year class (See Bowlby 1988b for details). This was done to reduce bias associated with our previous estimates (Malone 1986, 1987). These previous population estimates were high because of size-selectivity of the trapnets used for capture. Previously, there were too few marks and recaptures over a sufficient period of time to provide adequate precision for such stratification of our estimates.

The population 3-year-old and older walleye during spring 1987 in Eastern Lake Ontario was estimated to be 588,000 fish (Figure 1). This was a 29% decrease in the population despite recruitment of the 1984 year class into the population.

These estimates still have some deficiencies associated with spring sampling. In spring, for the most part only some spawning stocks are sampled. Although, there appears to be some mixture of spawning stocks, it is not complete. Also, younger year classes are poorly represented during spring sampling. Accordingly, future sampling should be confined to fall when the stocks are mixed and younger year classes are better represented in the samples.

AGE STRUCTURE/YEAR CLASS STRENGTH

The 1984 year class is quite obviously poorer than the 1983 and 1982 year classes which are larger at an older age (Figure 2). The age distribution of walleye in eastern Lake Ontario is dominated by the 1982 and 1978 year classes (5- and 9-year-olds). This distribution corresponds quite well to the density of young-of-year walleye in bottom trawl catches (Figure 3). If these relationships hold up then we are should expect good year classes for 1985, 1986 and 1987. Moreover, density of young-of-year walleye in 1986 suggests that the 1986 year class will be larger than than any other year class in the last two decades. Populations of walleye (3-year-old and older) should increase when these year classes are recruited.

When sufficient data is available we will attempt to develop a relationship between young-of-year density and population of 3-year-old walleye of the same year class in eastern Lake Ontario to predict populations before they are recruited.

Our spring trapnetting indicates that most female walleye reach maturity at age 4 in Lake Ontario. The strong 1982 year class occurred when the 1978 year class reached maturity, and that the strong 1986 year class occurred when the 1982 year class reached maturity. Similarly, Hurley (1986: Figure 7) shows, for Bay of Quinte walleye, a strong year class in 1955 was followed by strong year classes in 1959 and 1964 (4 and 5 year intervals). Although this is highly suggestive of a good stock recruitment relationship, environmental considerations must also be given equal weight. The strong 1978 year class was produced with almost zero spawners. Accordingly, future stock recruitment modelling should consider environmental and community structure effects.

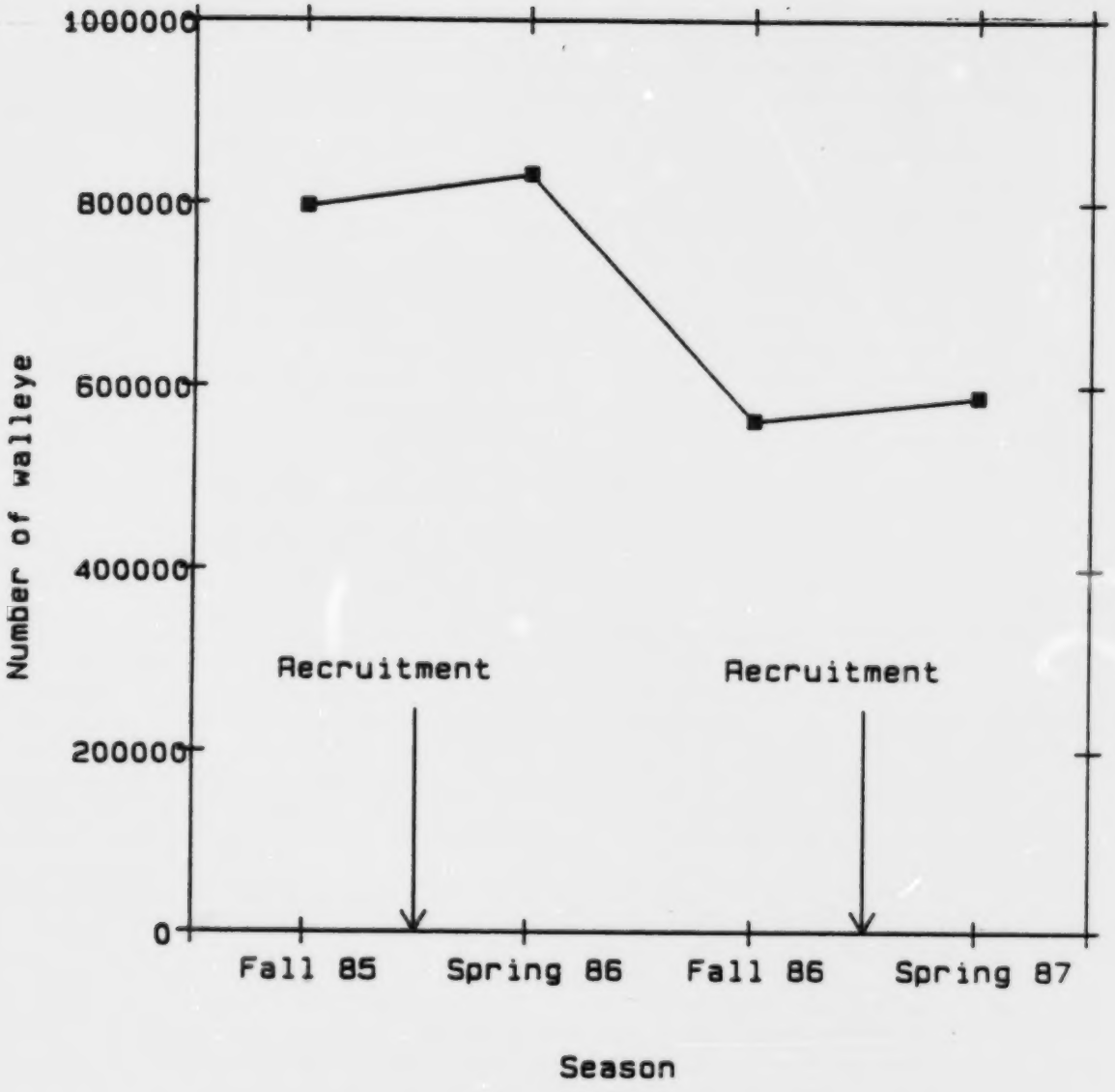

Figure 1. Population of 3-year-old and older walleye in eastern Lake Ontario. Estimates are based on age stratified Jolly-Seber models.

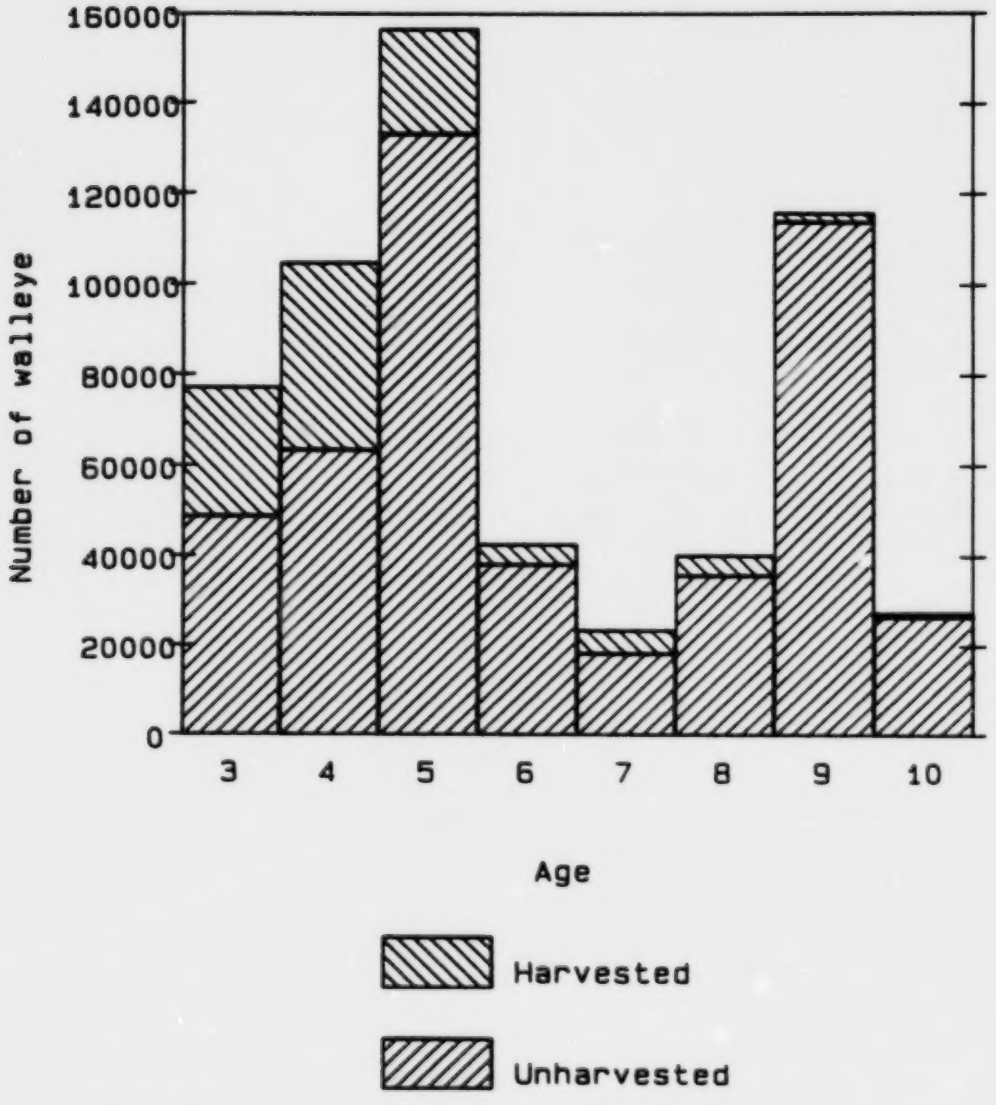

Figure 2. Population of walleye in eastern Lake Ontario during spring 1987, and the estimated open water harvest by age class.

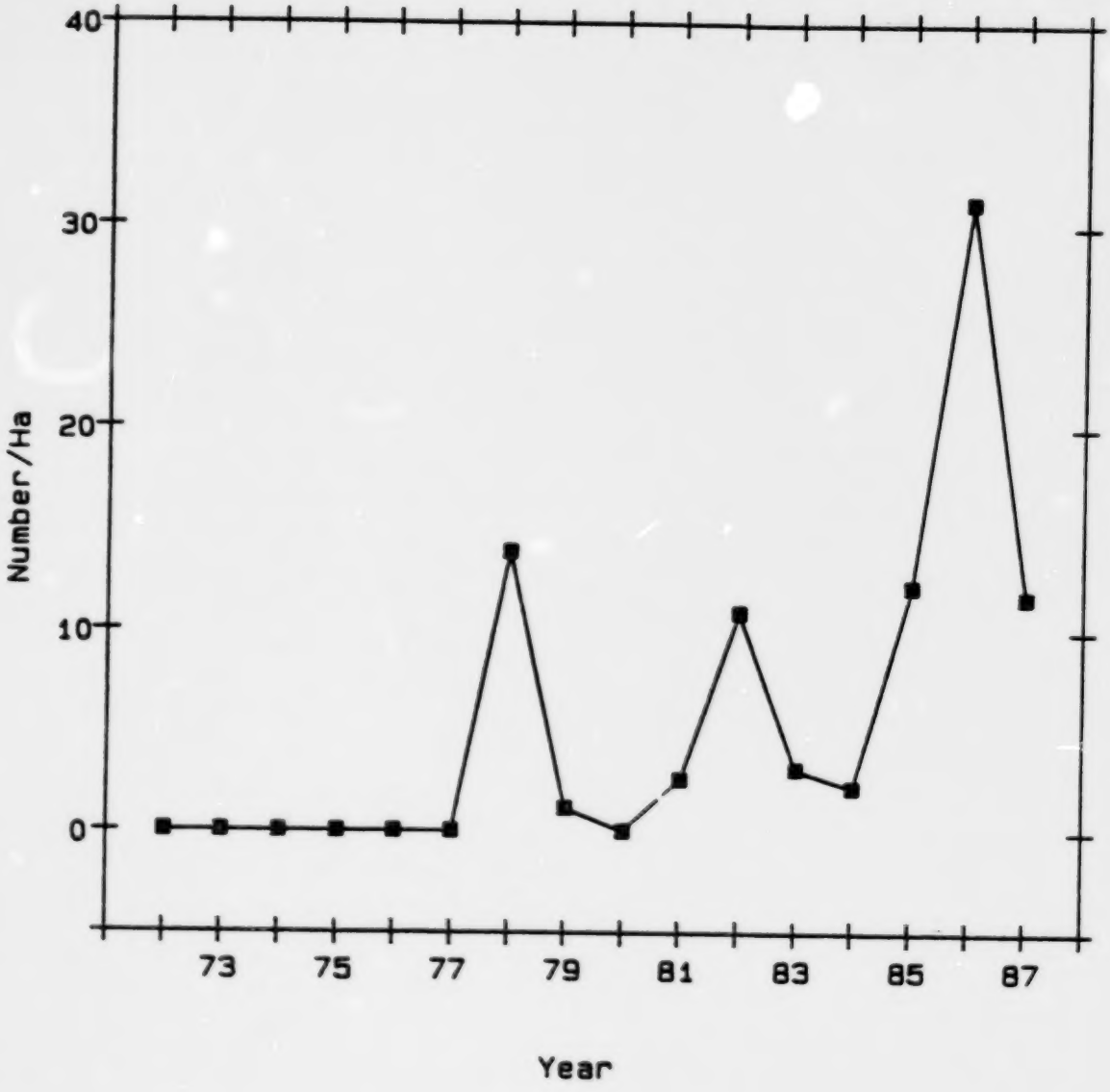

Figure 3. Estimates of density of young-of-year walleye in the Bay of Quinte. These estimates are means for Big Bay, Hay Bay, and the Adolphus Reach during May to October. Estimates are based on Glenora Fisheries Station bottom trawls (courtesy of D. Hurley).

HARVEST AND POPULATION RELATIONSHIPS

The 1987 summer angler harvest of walleye in the Bay of Quinte was 110,000 fish (see details in Mathers, 1988). The angler harvest was dominated by 3-, 4-, and 5-year-olds (Figure 2). However, angler selectivity is highest for 3- and 4-year-olds (Figure 4). Almost 40% of the 3-, and 4-year-old walleye were harvested. Considering the high selectivity of the angling fishery and the poor 1983 and 1984 year classes, it was not surprising that the harvest declined in 1987 despite higher angler effort (Mathers, 1988). Moreover, considering the high variability in year class strength (Figure 3), we should expect year to year variability in angler success to be a normal part of the fishery.

The relatively large population of 9-year-olds was almost untouched by the open water fishery. However, these older fish were taken in greater numbers during the 1986 ice fishery (Schaner, 1987). It was unclear if the lower rate of catch of larger/older walleye in the open water fishery was a result of migration of these fish to Lake Ontario where effort directed towards them is lower. Alternatively, anglers may not have used effective methods to catch these fish. However, research gillnets indicated that the older year classes were not present in the Bay of Quinte where most of the angling effort was directed (Figure 5). As well, increased numbers of incidentally caught walleye were found in the fall whitefish fishery along the south shore of Prince Edward County (Bowlby, 1988c). Ridgway *et al.* (1988) suggested that walleye may have moved out the Bay of Quinte in response to lower alewife abundance. Alewife were the major diet of walleye. His modelling indicates that prior to 1987 there was a surplus of alewife in the Bay of Quinte to support the walleye population, but in 1987 their was a deficit of alewife.

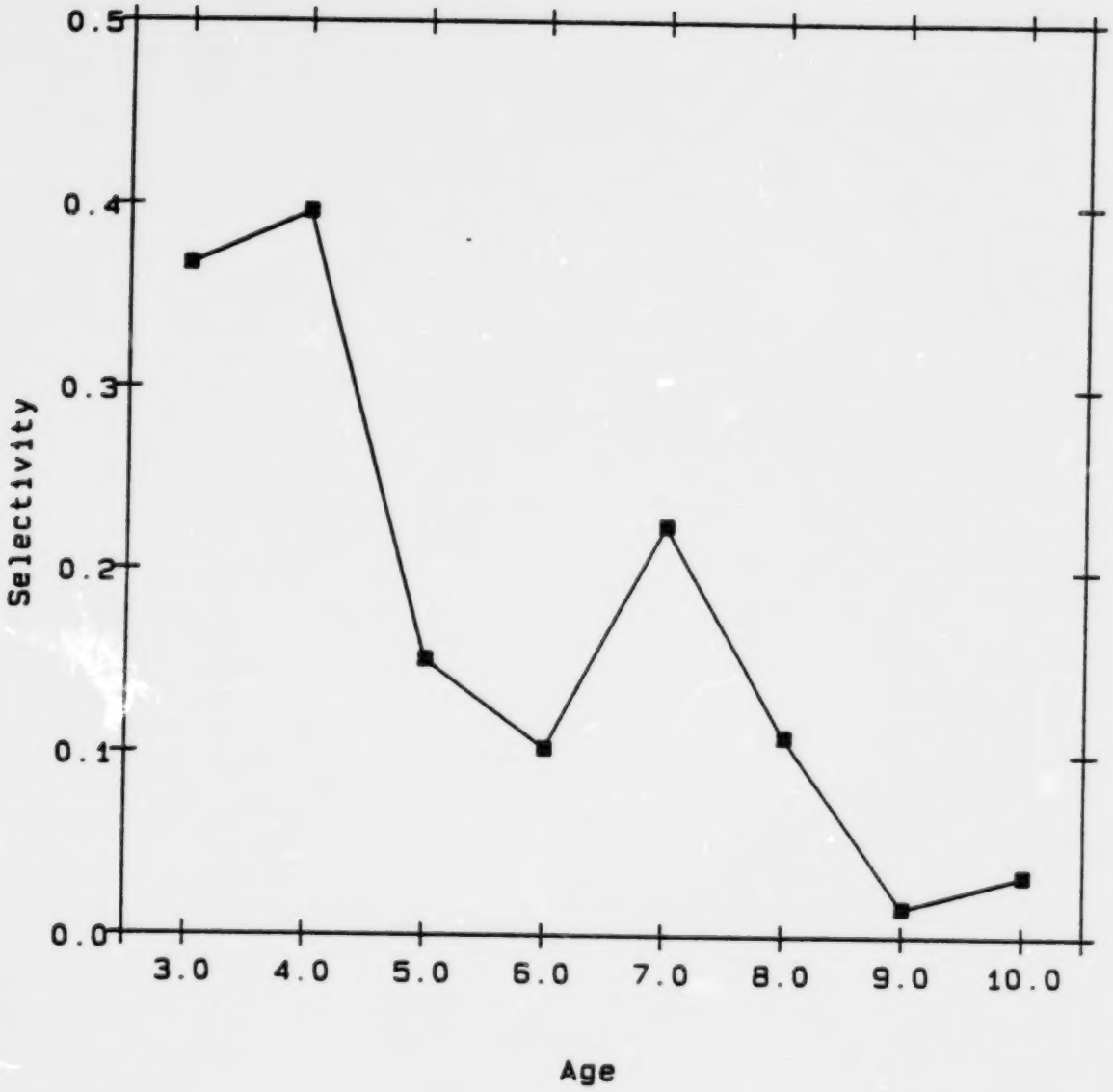

Figure 4. Selectivity of angling fishery for walleye in Eastern Lake Ontario during 1987 open water season. The age seven estimate is likely high as result of a population underestimate (compare Figures 2 and 5).

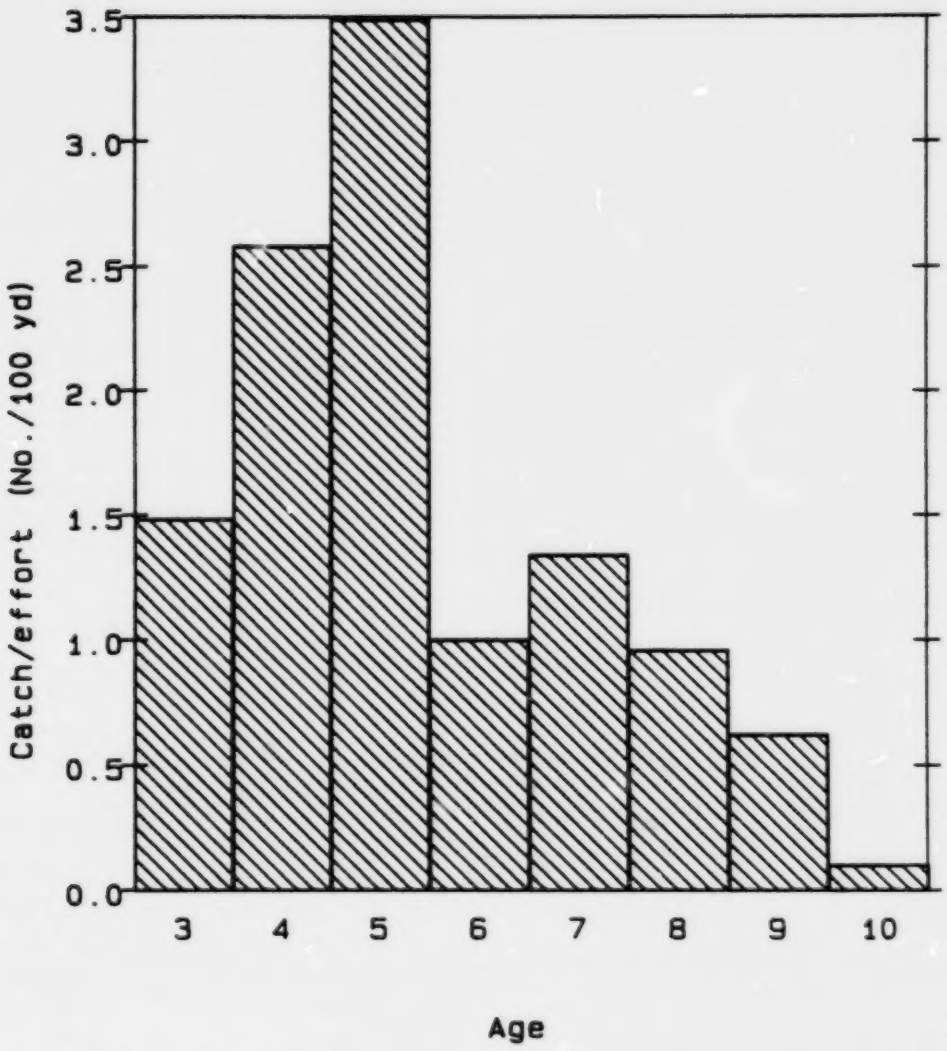

Figure 5. Age distribution of walleye in Glenora Fisheries Station gillnets in Hay Bay, Bay of Quinte during June to August 1987 (courtesy of D. Hurley).

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Great Lakes Fisheries Commission
Lake Ontario Committee Meeting
March 7-9, 1988

BAY OF QUINTE CREEL SURVEY, SUMMER 1987

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ABSTRACT

The angler effort during the 1987 Bay of Quinte open water walleye fishery was estimated at 669,202 rod hours. This fishery has continued to grow at a steady rate. Effort during the opening weekend is increasing faster than for the rest of the fishery. Our estimate of the current walleye harvest is 110,277 fish, which is a slight decline relative to past years.

RECOMMENDATIONS

1. Do a comprehensive (including all seasons) open water creel survey.

2. Investigate potential bias in the estimated age distribution of harvested walleye caused by using a gillnet age-length key on creel length distributions.

INTRODUCTION

The sports fishery in the Bay of Quinte is based mainly on walleye. The fishery usually consists of an ice fishery during the months of January and February and an open water fishery from May until freeze-up. The fishery is closed in the months of March and April to protect the walleye spawning in the tributaries of the Bay of Quinte.

The Lake Ontario Fisheries Unit has conducted creel surveys on the Bay of Quinte since 1979. Results of previous years' creel surveys have recently been summarized by Schaner (1986). This document describes the survey conducted during the 1987 open water fishery on the Bay of Quinte and provides comparative data from previous surveys.

METHODS

This survey was designed to combine aerial boat counts with interviews conducted with anglers on the water. This design is thought to increase the cost efficiency of the program by reducing the amount of time on the water during weekday time periods, which have relatively low angler activity.

The creel survey was stratified to reduce the variance of the estimates. This creel survey covered the Bay of Quinte from Trenton to Glenora and included 12 geographic strata (Figure 1). The creel was conducted from May 2, 1987, the opening day of the walleye season, until July 15, 1987 and this time period was divided into four seasons (a. opening weekend - May 2 and 3; b. rest of May - May 4 to 31; c. June; d. July). Day-types were stratified into weekdays and weekend days (including holidays) and the time of day was also subdivided (0700 to 1400, 1400 to 2100).

Creel survey clerks conducted roving interviews on the water on weekend periods only and estimates of fish catch and harvest rates were calculated. During the interviews the fork lengths of the fish harvested by the anglers where measured. Age composition of the walleye harvested was estimated using a fork length - age key calculated using May to July data from the 1987 Bay Index Gillnetting Program. Weight of walleye sampled was calculated using the following equation: $\log_{10}$ Wt(g) = -5.336 + 3.155 $\log_{10}$ Fl(mm) (Hurley 1986).

Fishing pressure was measured using aerial boat counts conducted evenly across day-types and time periods. Seven flights were conducted during the opening weekend season while twenty flights were conducted in each of the other seasons.

The data were entered and processed using the CREESYS 3.2 software package (Lester and Trippel 1985). Since no workday interviews were conducted, non-workday data were used to estimate HUE and the mean number of anglers per boat. The 1986 data showed that the

RESULTS AND DISCUSSION

Survey Estimates

The estimates of angler effort and harvest of walleye in the individual creel seasons suggest that the 1987 fishery has grown relative to previous years (Tables 1 and 2). The estimate of angler effort for the opening weekend fishery in particular has grown to almost double the level of past years. The catch and harvest estimates for all fish species are given in Appendix 1.

Table 1. Estimated angling effort (rod hours) in the Bay of Quinte summer fishery, 1981 to 1987. Estimates are given for each creel season including the opening weekend (when data are available).

Creel Season	Angler Effort (rod hours)						
	1981	1982	1983	1984	1985	1986	1987
Opening	-	-	-	47237	43959	49593	90113
May[a]	97119	144163	-	180511[e]	162162	253340	290225
June	62336	57126	-		58093	51949	81203
July	68401	71201	-	96607[b]	94711[b]	83075	82346[d]
Aug.	58505	70898	-	83127[b]	81495[b]	101738	137428[b]
Sept.	19426	25307	-	26960[b]	26431[b]	36635[b]	44571[b]
Oct.	9207	7572	-	13480[b]	13215[b]	18317[b]	22286[b]
Nov.	4704	6039[b]	-	6740[b]	6608[b]	9159[b]	11143[b]
Dec.	0[c]	0[c]	-	0[c]	0[c]	0[c]	0[c]
Totals	319401	382306	-	451581	442717	554213	669202

[a] May data include the opening weekend data.
[b] Estimate based on current year's May and June total and the trend through season from 1981.
[c] Fishing effort in December remains unquantified but is considered negligible.
[d] The July 1987 estimate is extrapolated from data from July 1 to July 15, 1987.
[e] Separate May and June estimates for 1984 are not available.

CUE's for workdays were 40% higher than for non-workdays (ANOVA on ranked CUE data, F=12.77, p=0.0004). Also, the mean number of anglers per boat is 10% lower on workdays than on non-workdays (ANOVA on log transformed data, F=33.75, p=0.0001) (Mathers 1987). These correction factors were applied to the non-weekday data in generating weekday effort and walleye harvest estimates.

To allow comparison of these data to those from previous years it was necessary to make extrapolations of angler effort and harvest for months not sampled. The data collected from July 1 to July 15 were used to make estimates for the whole month. The estimates for August to December were derived using the current year's May-June totals and the trend through season from the 1981 open water survey (Schaner 1987).

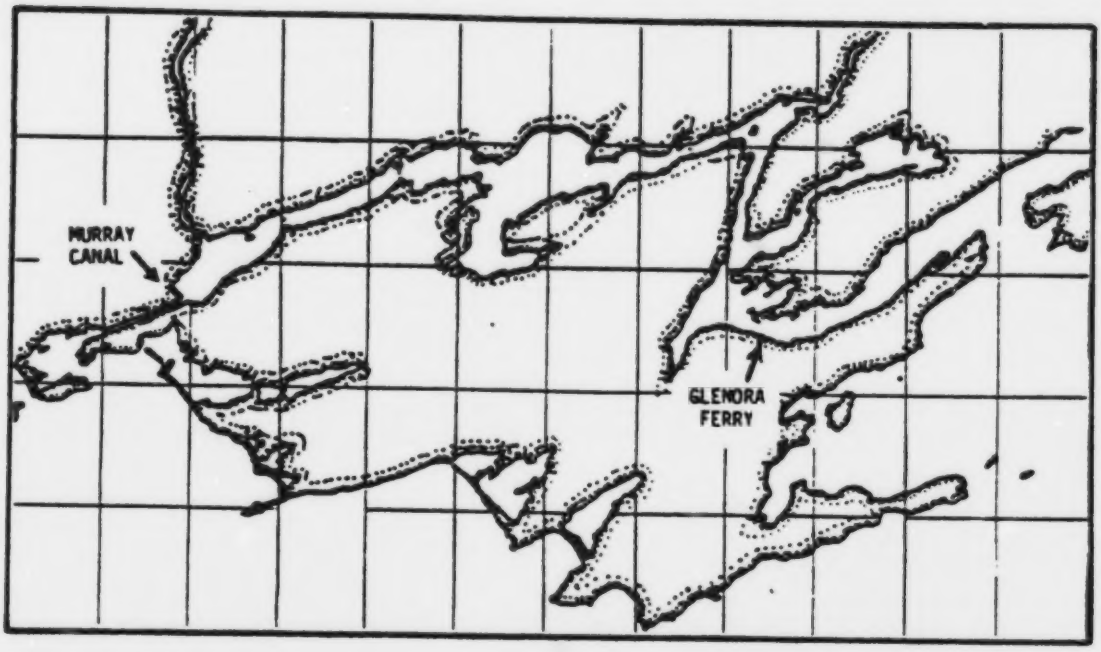

FIGURE 1. The Bay of Quinte showing the twelve areas used in the 1987 open water creel survey.

Table 2. Estimated walleye harvest (number of fish) in the Bay of Quinte summer fishery, 1981 to 1987. Estimates are given for each creel season including the opening weekend (when data are available).

Creel Season	Walleye Harvest (#'s)						
	1981	1982	1983	1984	1985	1986	1987
Opening	-	-	-	5527	11009	8507	17240
May[a]	56454	50232	-	55777[e]	65917	80962	75230
June	38096	8289	-		3793	5877	6617
July	40428	16308	-	24522[b]	27884[b]	15027	6332[d]
Aug.	19091	11743	-	11035[b]	12548[b]	18659	14732[b]
Sept.	2669	1381	-	1839[b]	2091[b]	2605[b]	2455[b]
Oct.	3606	1059	-	2452[b]	2788[b]	3474[b]	3274[b]
Nov.	1796	1170[b]	-	1226[b]	1394[b]	1737[b]	1637[b]
Dec.	0[c]	0[c]	-	0[c]	0[c]	0[c]	0[c]
Totals	162140	90182	-	102379	116415	128341	110277

[a] May data include the opening weekend data.
[b] Estimate based on current year's May and June total and the trend through season from 1981.
[c] Fishing effort in December remains unquantified but is considered negligible.
[d] The July 1987 estimate is extrapolated from data from July 1 to July 15, 1987.
[e] Separate May and June estimates for 1984 are not available.

Extrapolated Estimates

Data from the 1987 survey were extrapolated to estimate the angler effort and harvest for the whole open water season (Figure 2 and Tables 1 and 2). The results suggest that angler effort is continuing to grow. The walleye harvest estimate for the whole open water fishery is down slightly from the 1986 estimate. The data suggest that this decline was due to a relatively poor harvest in May and July. These changes are discussed below.

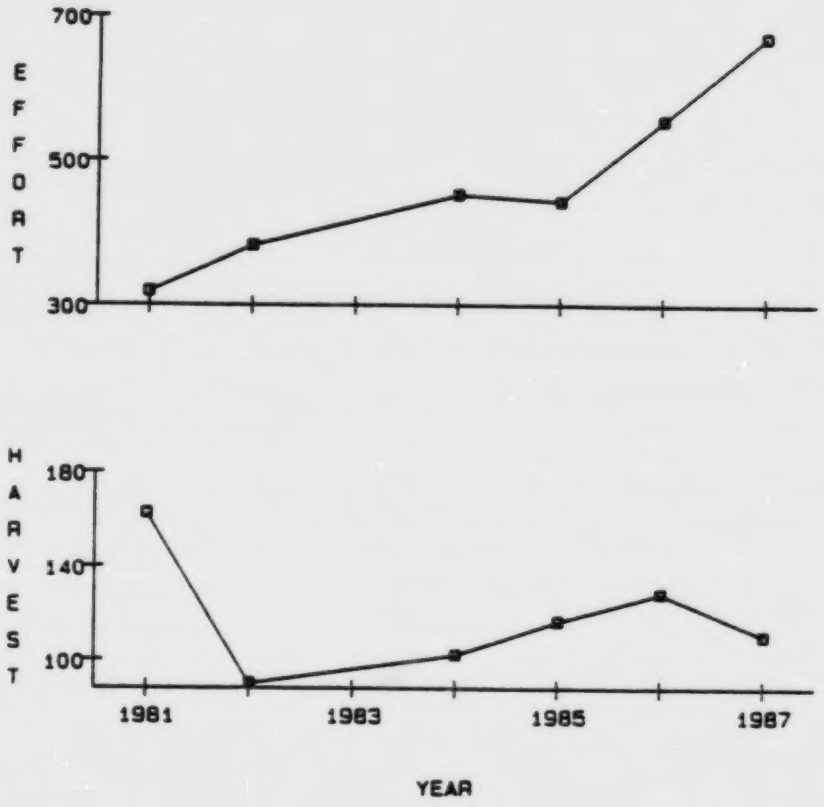

FIGURE 2. Trends in the Bay of Quinte sport fishery during the entire open water season. Shown are estimates of A) angler effort (in 1000's of angler hours), B) walleye harvest (in 1000's of fish).

Biological Characteristics of Catch

Eight hundred and thirty three walleye were sampled and their geometric mean fork length was 402 mm (95% Confidence Limits = 395 to 405). The mean age was 4.2 years (95% C.L.= 4.1 to 4.3) and the mean weight was 756 g (95% C.L. = 727 to 786). Three, four, and five year old walleye dominated the harvest (Figure 3).

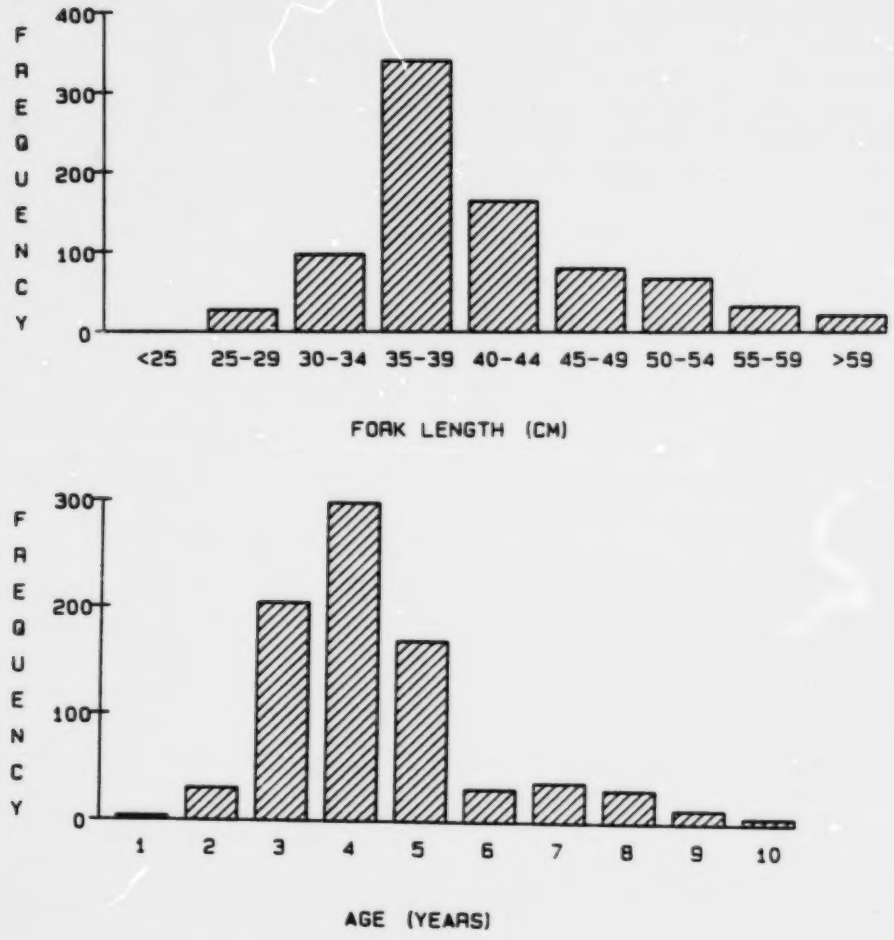

FIGURE 3. Fork length and age distributions of the walleye harvest sampled during the 1987 open water creel survey on the Bay of Quinte.

Year-Class Strength and Angler Harvest

The decline in harvest in conjunction with the increase in angler effort, described earlier, seems to indicate a relatively low abundance of walleye in the bay. Changes in abundance could be due to a variety of factors including: forage abundance, movement of walleye, year-class strength or some combination of these and other factors. Walleye year-class strength is highly variable in the Bay of Quinte (Hurley, personal communication). The strength of the 1984 and 1983 year-classes

(currently 3 and 4 years old) are poor relative to the 1982 year-class (currently 5 years old) (Bowlby and Mathers 1988). The current decline in the walleye harvest may be due to the relatively poor 1983 and 1984 year-classes. The 1985, 1986, and 1987 walleye year-classes are relatively strong; when these year-classes are recruited to the angler fishery, walleye harvests should return to higher levels.

It should also be noted that even with this decline in harvest the average walleye CUE observed in this fishery during 1987 was 0.263. Colby et al. (1979) state, in their synopsis of biological data on the walleye, that in general a good walleye fishery exists when they are caught at a rate of 0.3 fish per hour. The current catch rates appear low relative to past years, however, they still indicate a high quality walleye fishery.

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APPENDIX 1

Estimated catch and harvest of all fish species observed during the summer creel on Lake Ontario, May 2 to July 15, 1987.

Species	Estimated Catch	Estimated Harvest
Bowfin	66	0
Alewife	41	0
Brown Trout	49	0
Northern Pike	10349	2863
Muskellunge	64	0
White Sucker	231	0
Common Carp	577	0
Brown Bullhead	5984	1531
Channel Catfish	2978	607
American Eel	44	44
White Perch	32870	2995
White Bass	46139	1199
Rock Bass	28023	720
Pumpkinseed	2252	647
Smallmouth Bass	21160	761
Largemouth Bass	945	0
Yellow Perch	59192	6019
Walleye	139152	85375
Freshwater Drum	29383	3283

Great Lakes Fisheries Commission
Lake Ontario Committee Meeting
March 8-9, 1988

WHITEFISH POPULATIONS IN EASTERN LAKE ONTARIO AND THE BAY OF QUINTE, 1987

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ABSTRACT

Lake whitefish in eastern Lake Ontario can be divided into a Lake Ontario stock and a Bay of Quinte stock. The population of the Lake Ontario stock of whitefish (4 years old and older) has decreased 34% to 131,000 in 1987 from 1986. This decline has resulted from poor year classes of 4- and 5-year-old whitefish. The population is expected to increase when the strong 1985 year class (currently 2 years old) enters the population in 1989. The population estimate of the Bay of Quinte stock of whitefish (4 years old and older) has increased to 126,000 in 1986. This increase has resulted primarily from improvements to our sampling rather than an actual increase in the population.

The harvest of Lake Ontario stock whitefish in 1987 declined 22% in number to 21818 and 4% in weight to 46915 kg, despite increased number of net lifts and meters (yardage) of net set. Thus the catch per effort declined in this fishery. The harvest of Bay of Quinte stock whitefish (Quota Zone 4) in December 1987 increased in number and weight, in accordance with increased number of net lifts and length of net set, and so the catch per effort has changed little.

The catch of incidental "sports species" in Lake Ontario whitefish fishery (Quota Zone 2) in 1987 was about 12% of the catch by weight. The catch of incidental "sports species" in December 1987 in the North Channel and Adolphus Reach (Quota Zone 4) was about 20% of the catch.

Morphology data was collected from 22 whitefish captured in Lake Ontario Fisheries Unit index programs in the Kingston Basin of Lake Ontario during August 1987. Using discriminant function analysis on this data, 7 (32%) were classified as Bay of Quinte stock and 15 (68%) were classified as Lake Ontario stock.

We rejected the hypothesis of alternate year spawning of whitefish in Lake Ontario based on the pattern of tag returns.

RECOMMENDATIONS

1. Mark/recapture programs should attempt to capture whitefish at times of the year when the younger fish are mixed with the mature fish.

2. To avoid reliance upon the commercial fishery and to provide improvements in our estimates we recommend making Jolly-Seber population estimates with some size or age stratification. Such a change will require capturing more whitefish for mark/recapture purposes to make estimates with adequate precision.

3. Stock identification of whitefish should become a standard practice for index programs in the Kingston Basin and North Channel.

INTRODUCTION

Most lake whitefish (*Coregonus clupeaformis*) in Lake Ontario are found in the northeastern part of the lake where the habitat is most suitable. There are two stocks of whitefish in Lake Ontario and they can be differentiated on the basis of body morphology (Ihssen *et al.*, 1985). One stock spawns in the Bay of Quinte and the second stock spawns in Lake Ontario along the south shore of Prince Edward County. Whitefish stocks in Lake Ontario crashed in the 1960s and remained low during the 1970s, likely as a result of overfishing, and habitat degradation (Hurley and Christie, 1977). However, these stocks are now increasing, concurrent with habitat improvements, and quota management of commercial fishermen.

In this report, we describe the status of lake whitefish in eastern Lake Ontario and the Bay of Quinte.

MARK/RECAPTURE PROGRAMS

Two mark/recapture sessions were conducted during 1987. The spring session was conducted from April to June in Athol Bay and Wellington Bay of Lake Ontario, and was directed towards the Lake Ontario stock of whitefish. The fall session was conducted during October and November in the Bay of Quinte. Whitefish were captured in trapnets and marked with fin ray punches unique for each session and net location. As well, tags were applied to all marked whitefish during the spring session. In general, we followed the methods that were used in previous years (Malone, 1986; 1987). A complete description of the methods and sampling locations are found in Bowlby (1988a).

Our sampling likely over represents Maketewis Shoal, Big Bay, and Trent River spawning stocks in the Bay of Quinte because virtually all of our Bay of Quinte captures and recaptures occur at the spawning sites. There may be other stocks that spawn in the Bay. As well, we catch only spawning whitefish (4 years old and older), whereas the commercial fishery catches large numbers of younger whitefish (3 years old). Therefore, future mark/recapture programs should attempt to capture whitefish at other times of the year when the younger fish are mixed with the mature fish.

Population estimates are made using the modified Petersen method.

Recaptures of the Lake Ontario stock are made with the commercial fishery during fall. To avoid reliance upon the commercial fishery and to provide improvements in our estimates we propose to make Jolly-Seber population estimates with some size or age stratification. Such a change will require capturing more whitefish for mark/recapture purposes to make estimates with adequate precision.

Tag loss was was calculated by examining 10897 whitefish for tag scars. Twenty tag scars were found. Based on the number of fish examined for tags (21818) and the number of tags recovered (147) we estimated that 21.4 % of the tags were lost. We assumed that tag loss was due primarily to poorly applied tags and was therefore time independent. For population estimates the number of marked fish was reduced accordingly.

POPULATION SIZE AND AGE STRUCTURE

LAKE ONTARIO STOCK

The population of the Lake Ontario stock of whitefish (4 years old and older) has decreased 34% to 131,000 in 1987 from 1986 (Figure 1). This decline has resulted from poor year classes in 1982 and 1983 (4 and 5 years old; Figure 2). With the poor 1984 year class (3 years old) about to enter this population, it is expected to decline further to 87,000 in 1988. This estimate is based on applying the rate of population decline (0.661) from 1986 to 1987. This rate encompasses the recruitment and total mortality rates of the population. Application of this rate to the 1987 whitefish population is reasonable because the 1983 and 1984 year classes are similar in strength (Figure 2). However, a stronger 1985 year class (2 years old) is expected to enter the population (4 years old and older) in 1989 and at that time the population should increase.

See Bowlby (1988b) for the details of these calculations.

BAY OF QUINTE STOCK

The population estimate of the Bay of Quinte stock of whitefish (4 years old and older) has increased to 126,000 in 1986 (Figure 1). (Note that population estimates are made for the time of marking rather than the time of recapture. Hence, our estimates made from recaptures in 1987 are for 1986.) This increase has resulted primarily from improvements to our sampling rather than an actual increase in the population. This population is composed primarily of a strong 1982 year class (5 years old; Figure 3). With a poor 1983 year class (4 years old) in this population, it is estimated to have declined to 83,000 in 1987. This estimate is based on applying the rate of population decline (0.661) from 1986 to 1987 for the Lake Ontario Stock. This rate encompasses the recruitment and total mortality rates of the population. Application of this rate to the 1986 Bay of Quinte whitefish population is reasonable because relative year class strength is similar for the comparative recruiting year classes.

However, a stronger 1984 year class (3 years old) is expected to enter the population in 1988 (Figure 3). The 1987 population including 3-year-olds was estimated to be 120,000 (1.44 times greater than the population estimate

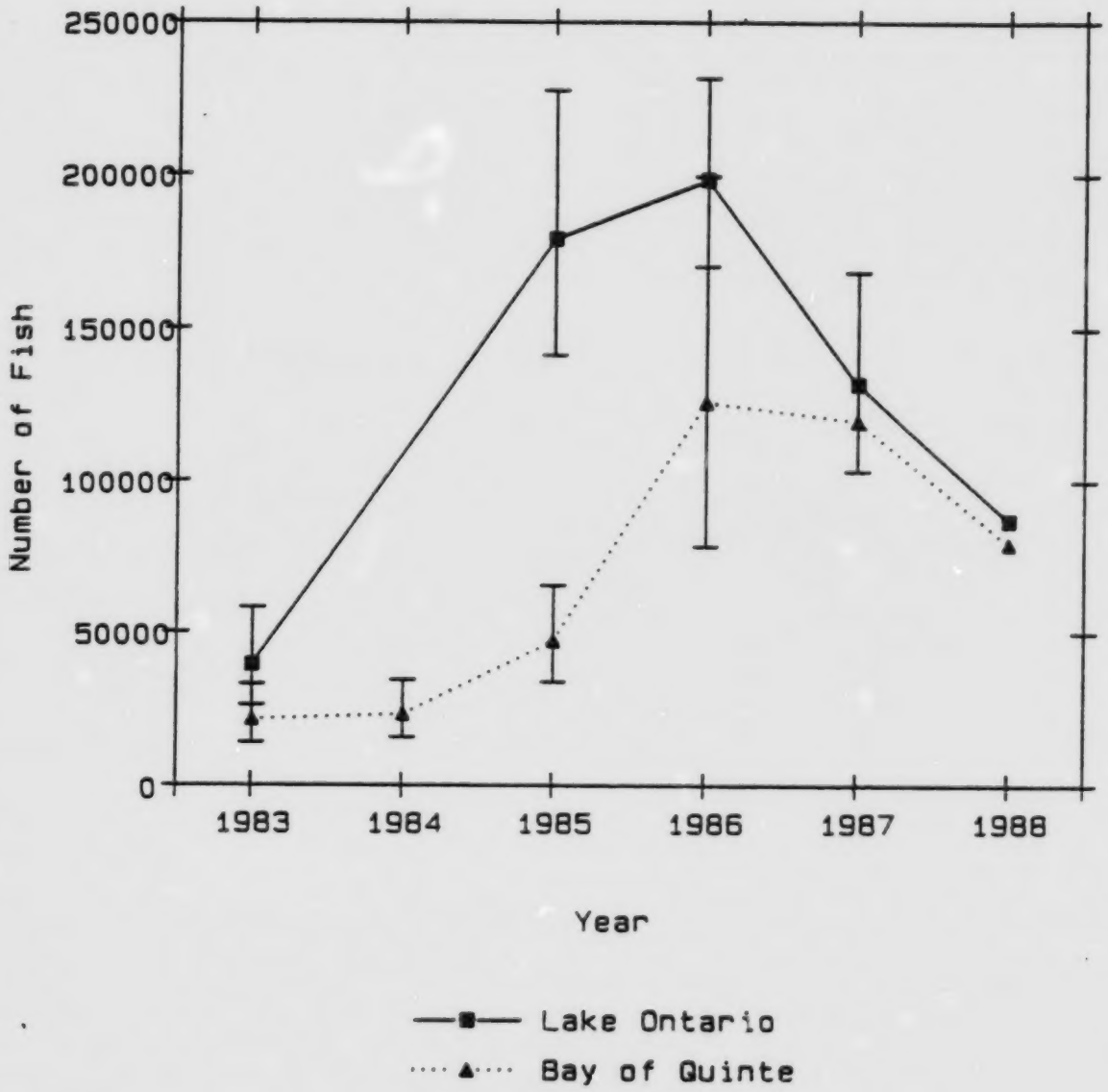

Figure 1. Petersen population estimates with 95% confidence intervals for whitefish 4 years old and older in eastern Lake Ontario. The estimates without confidence limits are projections based on recruitment and mortality.

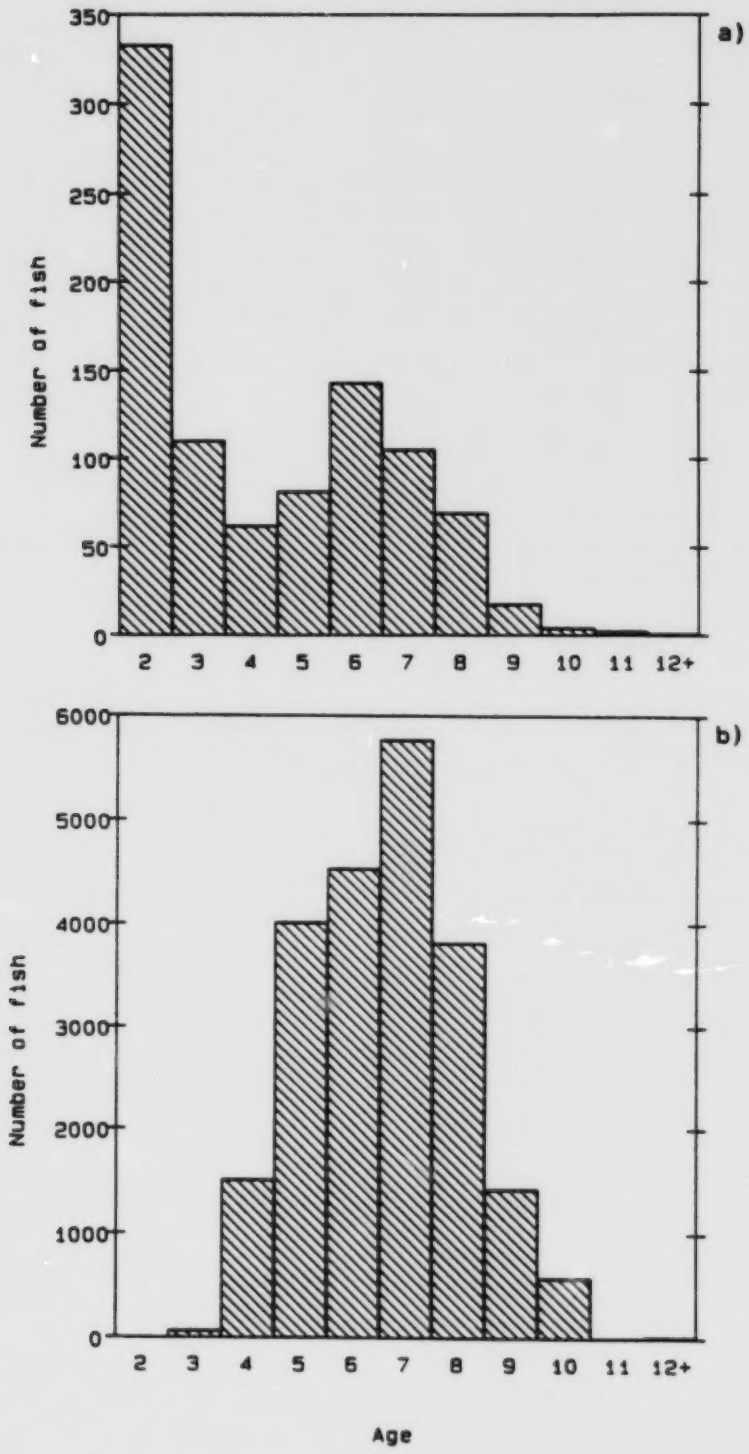

Figure 2. Age distributions of Lake Ontario stock whitefish from a) trapnets in spring 1987, and b) commercial gillnets in fall 1987.

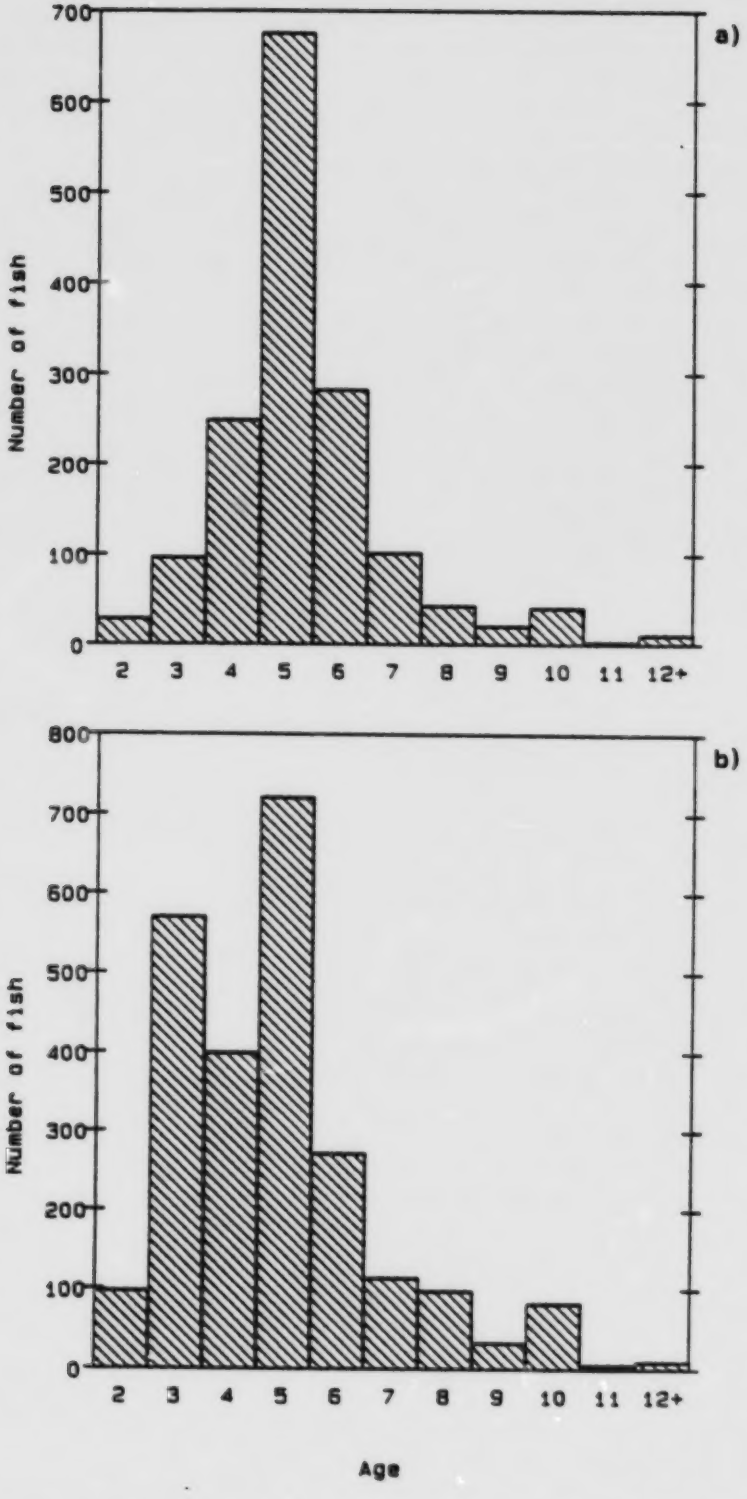

Figure 3. Age distributions of Bay of Quinte stock whitefish from a) trapnets in spring 1987, and b) commercial gillnets in fall 1987.

obtained above). The 3-year-olds were estimated from the difference in trapnet and commercial harvest catch curves (Figure 3). This estimate is likely low because the commercial gill nets are less selective for smaller 3-year-old fish than larger fish. The younger fish are not caught in these trapnets because only the spawning population is represented in the Bay of Quinte trapnet catches. Because we have no indication that the 1885 year class is strong, we have arbitrarily taken a conservative approach and applied the earlier used mortality/recruitment factor to the 1987 population of 3-year-olds and older to project the 1988 whitefish population (4 years old and older) to 79,000 fish.

HARVEST AND POPULATION RELATIONSHIPS

LAKE ONTARIO STOCK

The harvest of Lake Ontario stock whitefish (Quota Zone 2) in 1987 reflected the decline in population (4 years old and older) noted above. The harvest declined 22% in number (21818) and 4% in weight (46915 kg), despite increased number of net lifts and meters (yardage) of net set (Figures 4a-4d). Accordingly, the catch per effort has declined in 1987 (Figure 4e). The catch weight has not declined as much as the catch in numbers, because the average weight of whitefish has increased (Figure 4f). This situation is typical of "fishing up" a population. This refers to fishing one or more strong year classes as they increase in age, while later weak year classes fail to replace the population. Catches by weight do not change greatly because as the population declines the remaining fish continue to grow. This situation is expected to continue through 1988 until 1989 when the current 2-year-olds enter the fishery in significant numbers.

BAY OF QUINTE STOCK

The harvest of whitefish in Quota Zone 4 in December 1987 increased in number and weight, in accordance with increased number of net lifts and length of net set (Figures 4a-4d). The catch per effort has changed little in 1987 (Figure 4e). The catch weight has increased more than the catch in numbers, because the average weight of whitefish has increased (Figure 4f).

INCIDENTAL CATCH OF SPORTS FISH IN COMMERCIAL FISHERY

The catch of incidental "sports species" in the Lake Ontario whitefish fishery (Quota Zone 2) in 1987 was about 12% of the catch by weight of sports species and whitefish (Table 1). A few other species such as suckers, white bass and channel catfish were caught and harvested but these were typically about 1 % of the catch and have not been included in these comparisons. The weight of the incidentally caught fish were similar to the whitefish and so percentage by number or weight are quite similar.

From October 21 until November 9 the ratio of sports fish (salmonines, northern pike, smallmouth bass, and walleye) to whitefish was high (Figure 5). On a daily basis during this period the catch of sport fish sometimes exceeded

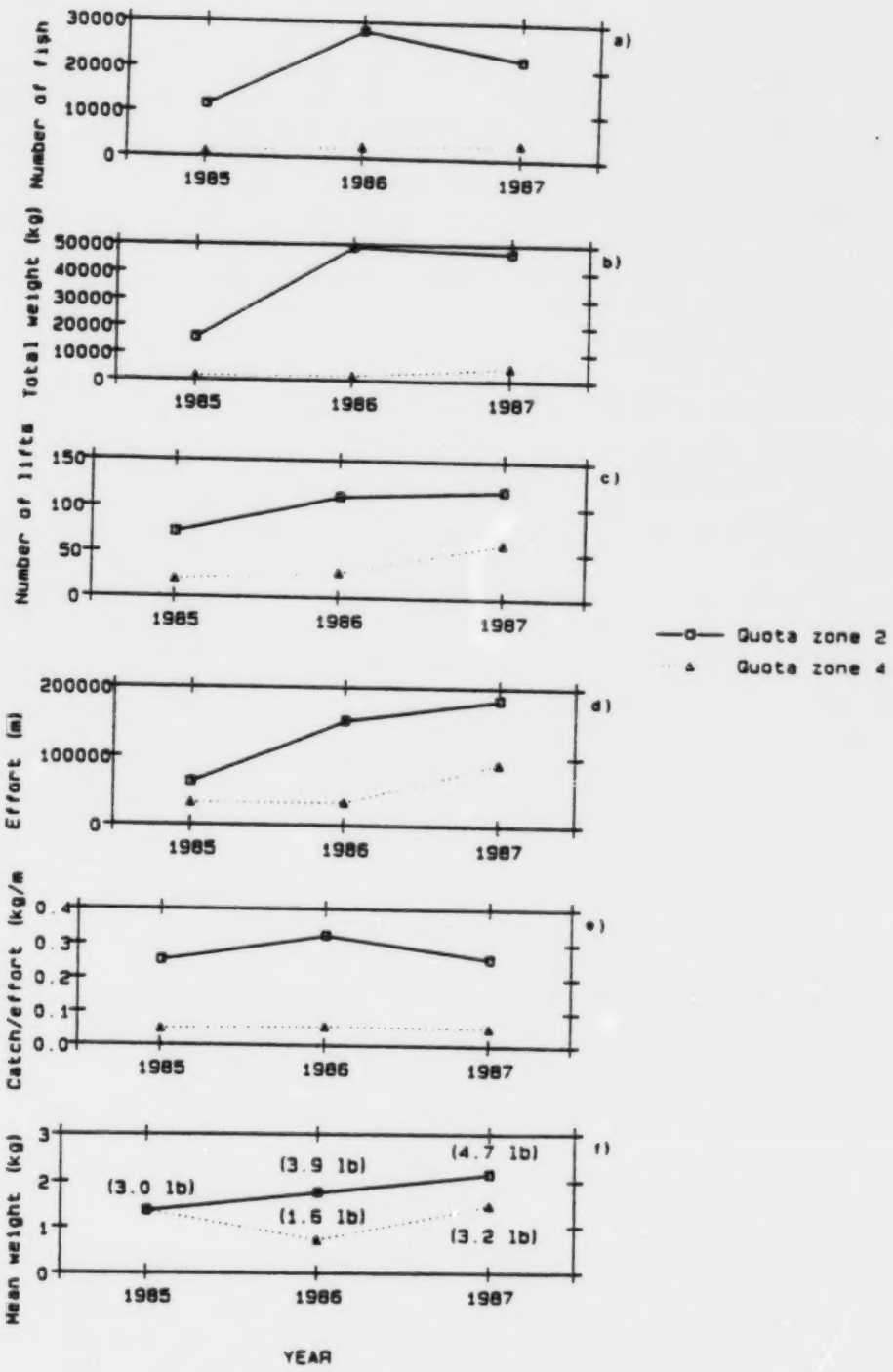

Figure 4. Yearly trends in commercial whitefish catch statistics in eastern Lake Ontario: a) number of whitefish harvested, b) weight of whitefish harvested, c) effort in number of lifts, d) effort in length of net, e) catch per effort, and f) mean weight of a whitefish in the catch.

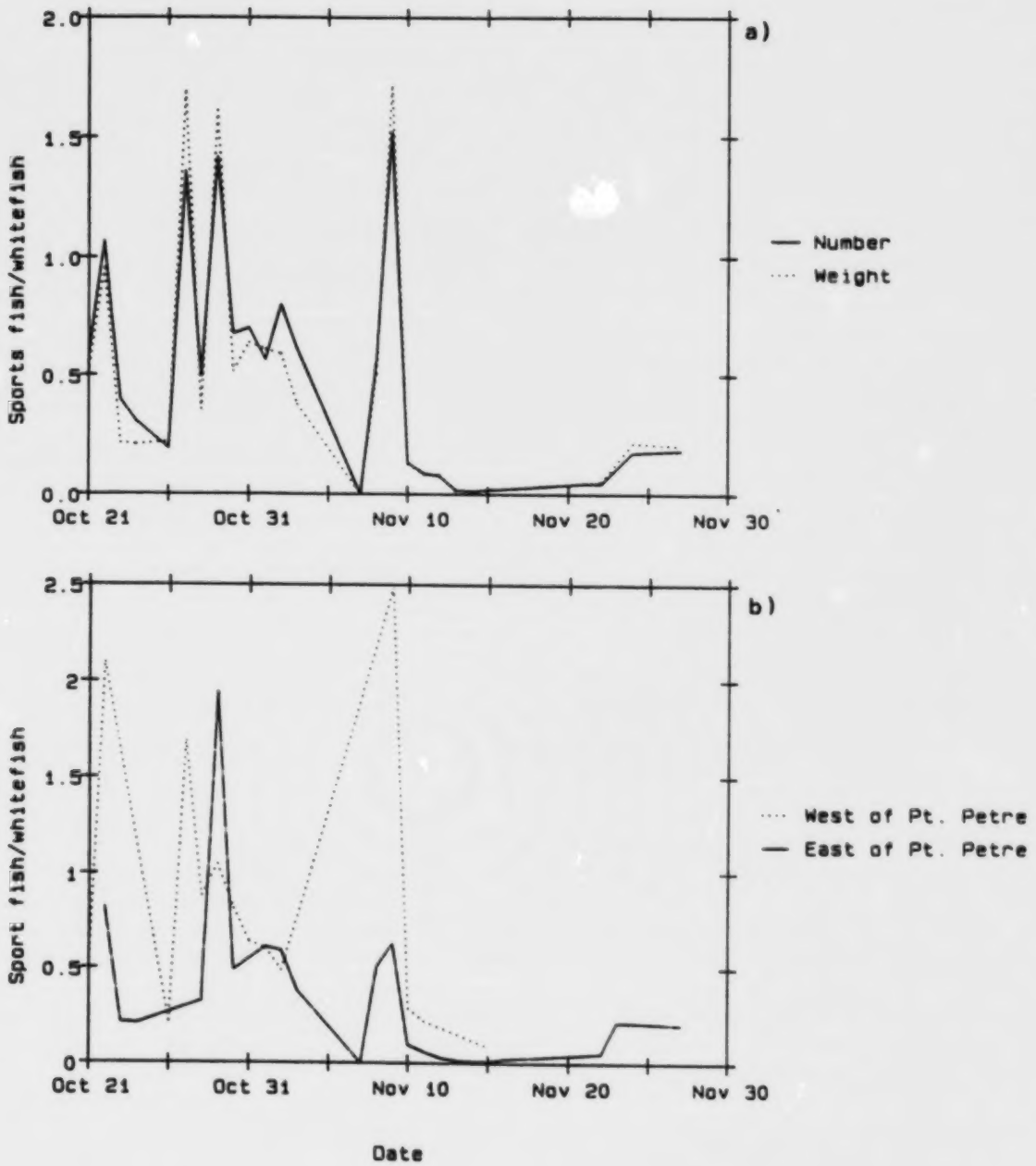

Figure 5. Ratio of sports fish to whitefish in commercial fishery in Lake Ontario (Quota Zone 2) during 1987: a) total catch, and b) weight by location (excludes one catch on Traverse Shoal).

Table 1. Catches of whitefish and sports species in the commercial whitefish fishery during fall 1987. Other commercial species such as white perch and suckers, and unharvested species such as alewife and gizzard shad are not included here in the percentage calculations and are less than 1% of the catch by weight.

Fish species	Quota Zone 2		Quota Zone 4		Quota Zone 2		Quota Zone 4	
	Number	Weight	Number	Weight	%Number	%Weight	%Number	%Weight
Coho salmon	3	4.1	0	0	0.01	0.01	0.00	0.00
Chinook salmon	9	34.5	10	4.8	0.04	0.07	0.30	0.11
Rainbow trout	10	8.3	4	2.3	0.04	0.02	0.12	0.05
Atlantic salmon	1	2.7	0	0	0.00	0.01	0.00	0.00
Brown trout	116	217.2	67	78.3	0.46	0.41	2.04	1.71
Lake trout	1598	3229.7	472	636.5	6.35	6.11	14.36	13.93
Northern pike	48	99.8	4	11.3	0.19	0.19	0.12	0.25
Smallmouth bass	390	278.1	1	0.3	1.55	0.52	0.03	0.01
Walleye	1163	2236.0	100	168.4	4.62	4.22	3.04	3.68
Total sport species	3338	6120.5	658	902.0	13.27	11.54	20.02	19.73
Lake whitefish	21818	46915.4	2629	3668.6	86.73	88.46	79.98	80.27

the catch of whitefish. However, beginning on November 10 and thereafter the ratio of sport fish to whitefish was low, which corresponded to increased catches of whitefish coinciding with decreased catches of sport fish (Figure 6).

Catches west of Point Petre tended to have a higher proportion of sports species in the catch than catches between Point Petre and Prince Edward Point (Figure 5). In addition, one catch at Traverse Shoal (east of Prince Edward Point) caught 18.5 sports fish for each whitefish.

The catch of incidental "sports species" in December 1987 in the North Channel and the Adolphus Reach was about 20% of the catch of sports species and whitefish (Table 1). A few other species such as suckers, white bass and channel catfish were caught and harvested but these were typically about 1% of the catch and have not been included in these comparisons. The weight of the incidentally caught fish were similar to the whitefish and so percentage by number or weight are quite similar. The number of incidentals per catch remained relatively constant through December (Figure 7).

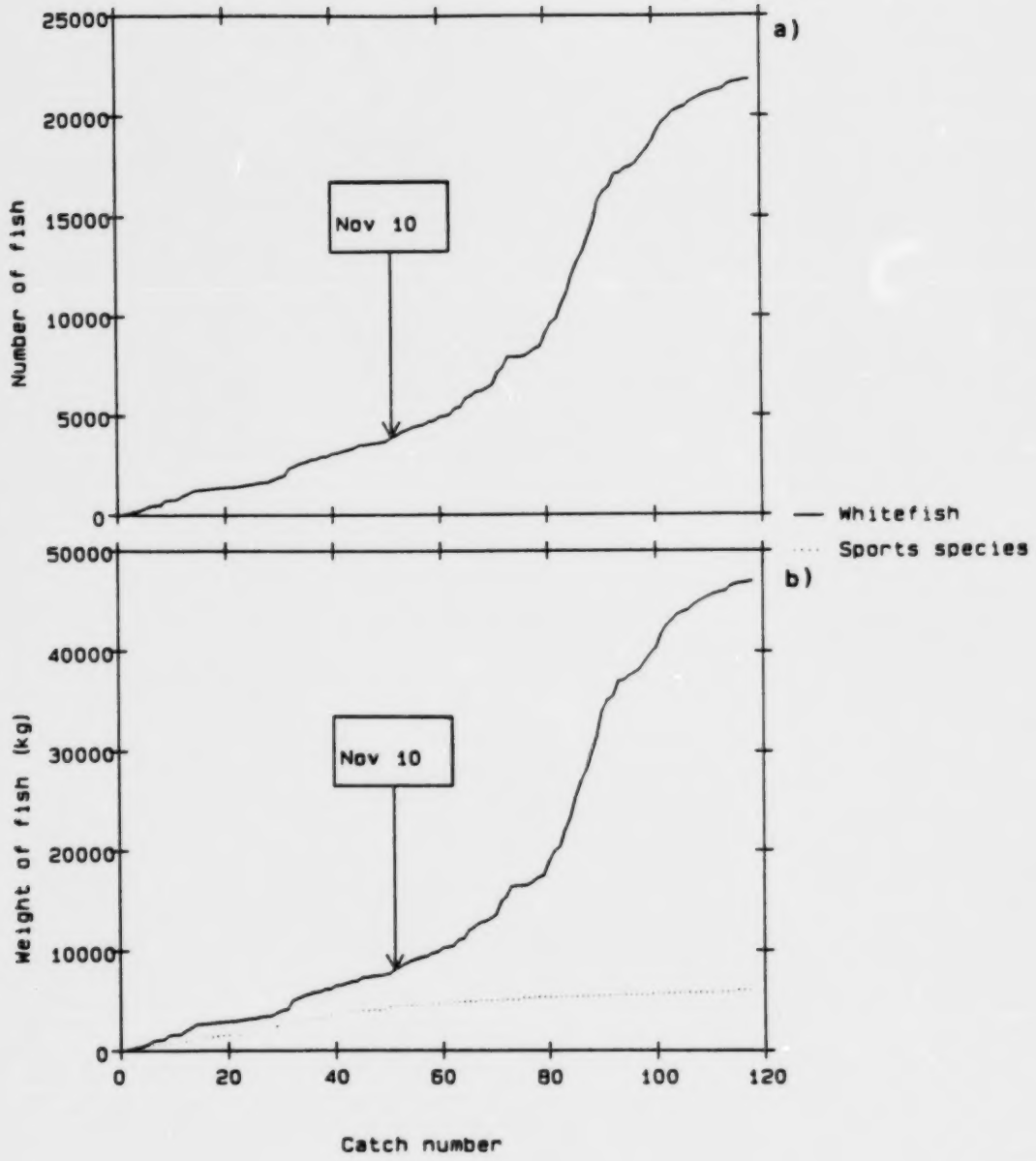

Figure 6. Cumulative catch of whitefish and sports fish in commercial whitefish fishery in Lake Ontario (Quota Zone 2) during 1987: a) number, and b) weight.

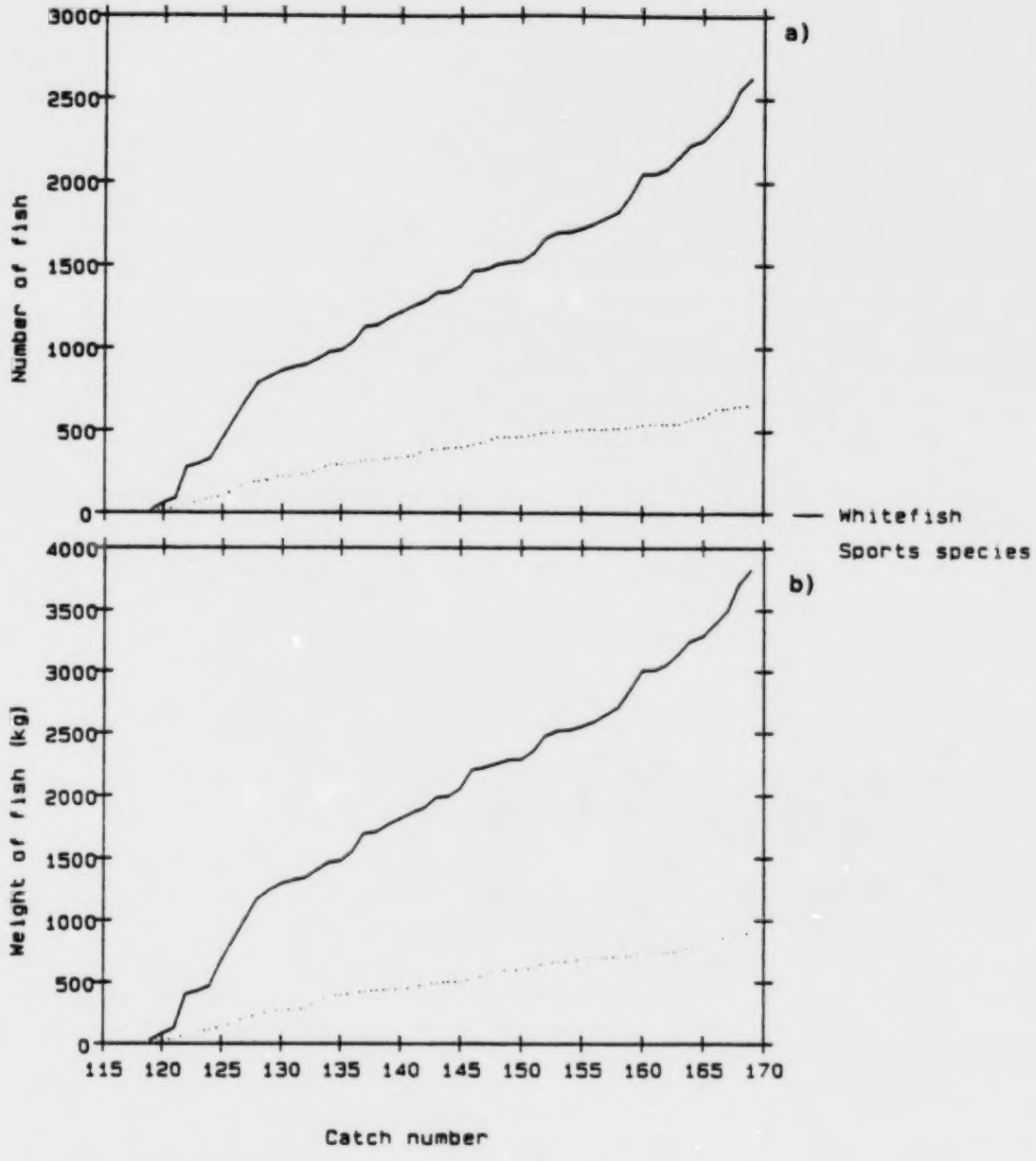

Figure 7. Cumulative catch of whitefish and sports fish in commercial whitefish fishery in the Bay of Quinte (Quota Zone 4) during 1987: a) number, and b) weight.

WHITEFISH MORPHOLOGY STUDIES

Currently, we can differentiate between Bay of Quinte and south shore Prince Edward County spawning stocks of whitefish, using discriminant function analysis (Ihssen et al., 1985) If there are other stocks of whitefish in Lake Ontario, we hope that the other stocks can be recognized as being different from these stocks.

Morphology data was collected from 22 whitefish captured in Lake Ontario Fisheries Unit index programs in the Kingston Basin of Lake Ontario during August 1987. The following morphology variables were measured or counted:

- total length
- fork length
- sum of the pectoral fin rays
- sum of the anal fin rays
- fish depth
- dorsal fin length
- anal fin length
- pectoral fin length
- interorbital width across top of head.

These variables were transformed according to Ihssen (1984) before classification in a quadratic discriminant function analysis (DISCRIM procedure of SAS). Calibration data was from 187 Lake Ontario and Bay of Quinte whitefish collected in 1982.

Of the 22 whitefish from 1987, 7 (32%) were classified as Bay of Quinte stock and 15 (68%) were classified as Lake Ontario stock. The locations in which Bay of Quinte and Lake Ontario classified whitefish were caught did not differ appreciably.

These results have bearing on our use of index stations in the Kingston Basin to index whitefish populations in eastern Lake Ontario. Currently, we manage the Bay of Quinte and Lake Ontario stocks of whitefish independently, because year class strength and harvesting differs between the stocks. However, the historical data base from the Kingston Basin does not differentiate between these stocks and therefore may prove to be difficult to use to develop management models. If index programs are to be continued in the Kingston Basin to index whitefish populations, then stock identification of whitefish should become a standard practice.

ALTERNATE YEAR SPAWNING

Alternate year spawning was hypothesized by Malone (1987) based on relatively higher proportions of tag returns during 1986 for whitefish tagged two and four years prior.

Although support for this hypothesis comes from recaptures of whitefish tagged in 1982 and 1984, the data from 1981 and 1983 do not support alternate year spawning (Table 2). The alternating pattern appears to come from low number of recaptures in 1983 and 1985 across all tagging years. This pattern could result from nonreporting of tags by the commercial fishermen, from

incorrect estimates of effort for particular years, or from incomplete mixing of marked and unmarked whitefish in combination withe clumped commercial fishing effort.

Table 2. Number of tag returns/effort from commercial fishermen for whitefish tagged during fall spawning run and subsequently recaptured during a later fall spawning run in Lake Ontario off the south shore of Prince Edward County.

Year of recapture	Year of tagging 1981	1982	1983	1984
1983	0.00	20.09		
1984	542.36	154.96	594.01	
1985	127.75	15.97	191.63	47.91
1986	78.23	126.38	150.45	78.23
1987	55.19	50.18	30.11	5.02

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CATCHES IN SMALL MESH GILL NETS DURING MAY & JUNE 1987 IN EASTERN LAKE ONTARIO

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ABSTRACT

Incidental catches of various sport fish species in small mesh gill nets continues to pose difficult problems for managers. Few defensible statistics are available. This study collected data on incidental catch rates as they occurred in a government run fishery designed to mimic or simulate the small mesh commercial yellow perch fishery in eastern Lake Ontario during May and June of 1987. By weight, yellow perch comprised 14% to 50% of the catch, depending on the time and area where the fishing took place. In terms of estimated weights, the most important sport fish species taken incidentally were lake trout, walleye, smallmouth bass and northern pike. The summary which follows has been distributed to various commercial and sport fish user groups.

RECOMMENDATIONS

1. An incidental catch monitoring program of onboard sampling should be conducted to determine incidental catch rates in other commercial fisheries in eastern Lake Ontario.

Caution Statement:

The data in this summary only apply to the yellow perch fishery during May and June of 1987. These results should not be applied to other types of commercial fishing activity, to other months of the year, or to other years.

BACKGROUND

The incidental catch of sport fish species in the commercial gillnet fishery in eastern Lake Ontario has become a major issue in recent years.

The Canadian waters of eastern Lake Ontario support sport fisheries, primarily for salmonids and walleye, worth several million dollars a year. The walleye fishery of the Bay of Quinte and Lake Ontario is self-

Incidental catches in commercial gill nets have the potential to significantly impact fisheries management objectives. Commercial fishermen complain that these catches can be large, for example in the spring smelt fishery. Observations by OMNR staff also indicate substantial incidental catches of non-target species in small mesh gillnets. Complaints of large incidental catches led to a corporate decision to investigate, during the months of May and June, the level of incidental catch of non-target fish species in the small mesh yellow perch gillnet fishery.

STUDY METHODS

The study was structured into three 19 day time periods. It encompassed three quota zones subdivided into five areas, each which contained three 5 min. grids (see Figure 1 and 2). Each grid was sampled at least once with two different gangs of net during each of the three time periods. Each gang contained three randomly arranged 250 yard long panels of monofilament gill net measuring 2 1/4", 2 3/8" and 2 5/8" stretched mesh. This net had been acquired form the commercial fishermen during the recent buy out program. The OMNR crew attempted to fish the nets in approximately the same way and at the same locations as used by the commercial fishermen. Forty sets (29,232 yds) were fished: 6 in Brighton, 8 in each of Adolphus Reach, the North Channel and south of Amherst Island, and 10 in Prince Edward Bay as follows:

MESH:	2 1/4"	2 3/8"	2 5/8"
Quota Zone 1	1545 yards	1490 yards	1484 yards
Quota Zone 4	4115 "	4000 "	2982 "
Quota Zone 2.1	4620 "	4500 "	4496 "

Temperature and weather data were collected. All fish were sampled using standard OMNR techniques, and disposed of in the usual manner. Finally, all data were entered into computerized databases and analyzed.

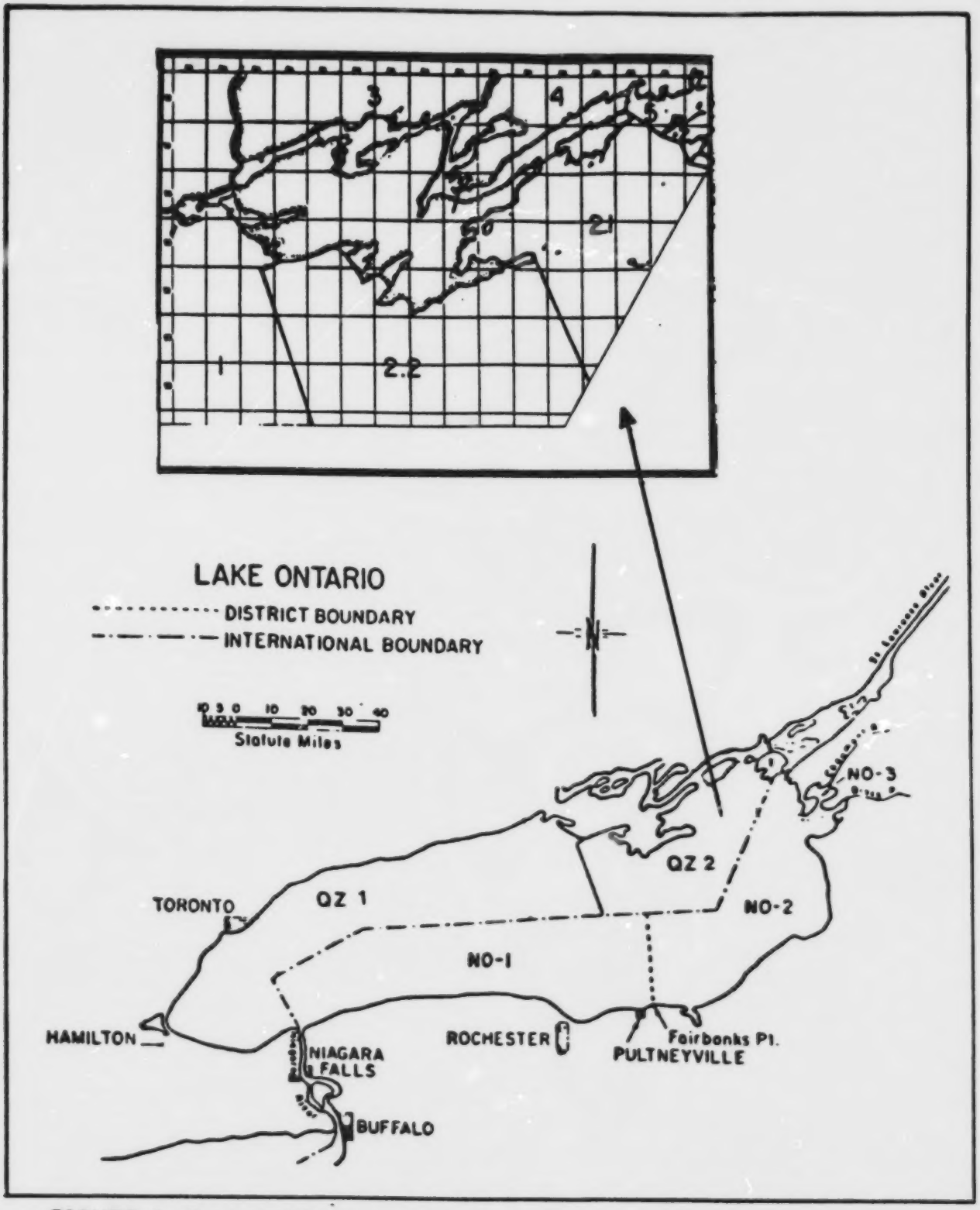

FIGURE 1: Commercial harvest statistics are reported by quota zones (QZ) in Ontario and commercial fish districts in New York (NO-). The inset shows detail in eastern Lake Ontario. The assessment unit has further subdivided QZ 2.

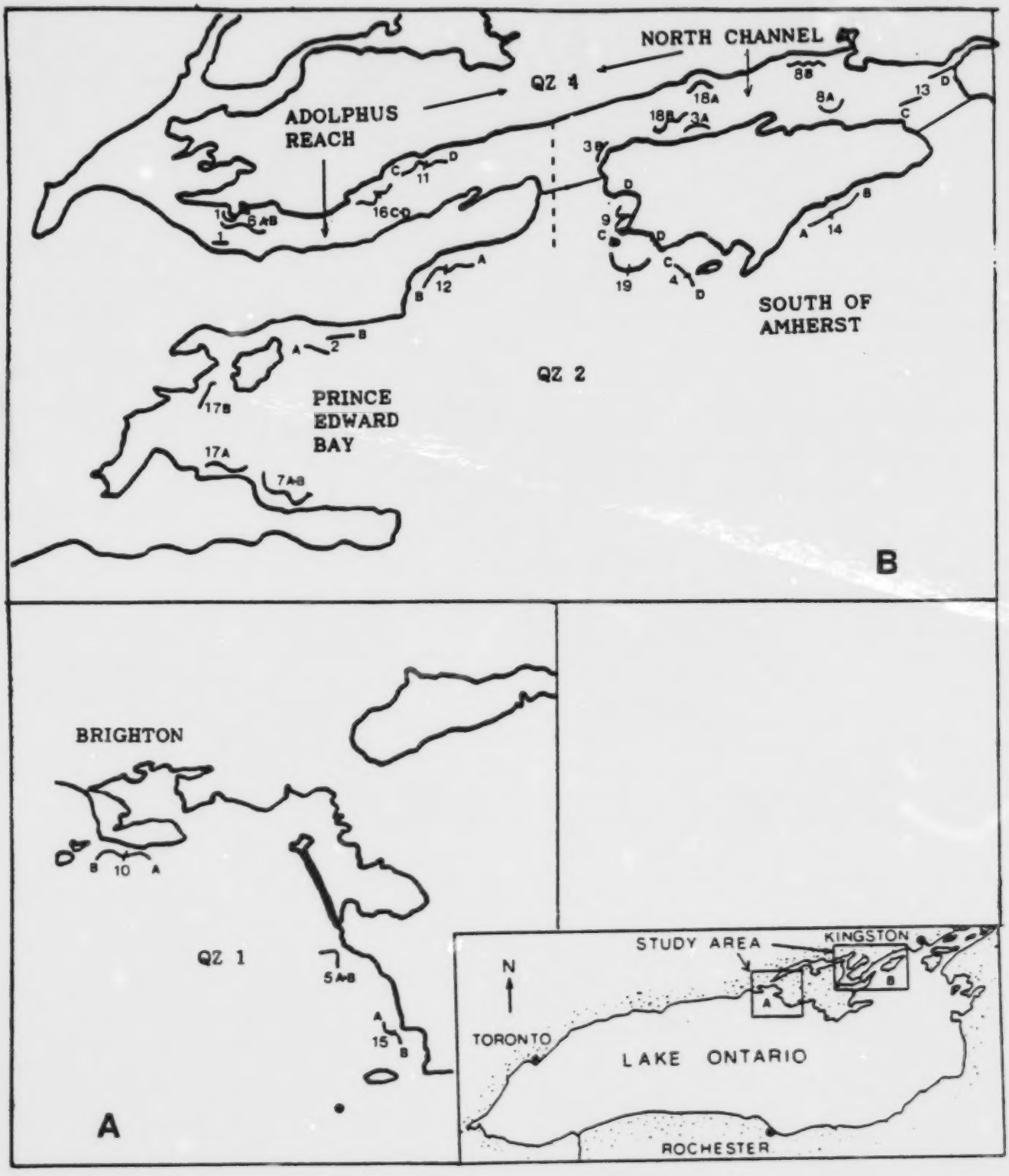

FIGURE 2: Inset A shows set locations in the Brighton and Wellington areas (Quota Zone 1). Inset B shows the location of sets in North Channel and Adolphus Reach (QZ 4), and south of Amherst Island and in Prince Edward Bay. Railed sets are shown as wavy lines.

RESULTS

The results are presented in the form of questions and answers, quoted directly from the report released by OMNR in January 1987.

Question 1: **What was the target species, and how many sport and commercial fish were caught by OMNR staff during the 1987 May and June study?**

Answer: The target species was yellow perch. OMNR catches were as follows:

NUMBERS CAUGHT BY LOFU DURING MAY BY QUOTA ZONE

SPECIES	MAY_QZ1	MAY_QZ2.1	MAY_QZ4
L TROUT	92	24	14
B TROUT	1	3	3
Y PICKEREL	0	11	189
N PIKE	0	9	3
SM BASS	0	16	25
Y PERCH	7	576	757
R BASS	23	365	312
W PERCH	18	44	692
L WHITEFISH	2	1	15
R WHITEFISH	10	0	0
SMELT	8	3	0
L HERRING	38	1	0
CW SUCKER	12	8	22
SUNFISH	0	0	1
SPORT TOTS	93	63	234
COMM TOTS	118	998	1799
ALL TOTS	211	1061	2033

NUMBERS CAUGHT BY LOFU DURING JUNE BY QUOTA ZONE

SPECIES	JUN_QZ1	JUN_QZ2.1	JUN_QZ4
L TROUT	30	8	1
B TROUT	0	0	2
Y PICKEREL	0	11	541
N PIKE	0	3	8
SM BASS	0	96	72
Y PERCH	98	1377	391
R BASS	34	753	542
W PERCH	14	69	563
L WHITEFISH	1	0	0
R WHITEFISH	1	0	0
SMELT	0	0	0
L HERRING	77	1	0
CW SUCKER	10	7	34
SUNFISH	0	0	1
SPORT TOTS	30	118	624
COMM TOTS	235	2207	1531
ALL TOTS	265	2325	2155

Question 1 - cont'd

NUMBERS CAUGHT BY LOFU DURING MAY AND JUNE IN ALL QUOTA ZONES COMBINED

SPECIES	MAY_TOT	JUN_TOT	MAYJUN_TOT
L TROUT	130	39	169
B TROUT	7	2	9
Y PICKEREL	200	552	752
N PIKE	12	11	23
SM BASS	41	168	209
Y PERCH	1340	1866	3206
R BASS	700	1329	2029
W PERCH	754	646	1400
L WHITEFISH	18	1	19
R WHITEFISH	10	1	11
SMELT	11	0	11
L HERRING	39	78	117
CW SUCKER	42	51	93
SUNFISH	1	1	2
SPORT TOTS	390	772	1162
COMM TOTS	2915	3973	6888
ALL TOTS	3305	4745	8050

NUMBERS CAUGHT BY LOFU DURING MAY AND JUNE IN EACH QUOTA ZONE

SPECIES	MAYJUN_QZ1	MAYJUN_QZ2.1	MAYJUN_QZ4
L TROUT	122	32	15
B TROUT	1	3	5
Y PICKEREL	0	22	730
N PIKE	0	12	11
SM BASS	0	112	97
Y PERCH	105	1953	1148
R BASS	57	1118	854
W PERCH	32	113	1255
L WHITEFISH	3	1	15
R WHITEFISH	11	0	0
SMELT	8	3	0
L HERRING	115	2	0
CW SUCKER	22	15	56
SUNFISH	0	0	2
SPORT TOTS	123	181	858
COMM TOTS	353	3205	3330
ALL TOTS	476	3386	4188

Question 2: How many lb. of sports fish were caught by OMNR during the 1987 May and June study for every lb. of commercial fish caught by OMNR during this study?

Answer: Catch weights are summarized in the tables below. A total of 1,061 LB. of sport fish (42%) and 1,476 LB. of commercially salable fish (58%) were caught during this study (alewife excluded).

Question 2 - cont'd

LB. CAUGHT BY LOFU DURING MAY IN EACH QUOTA ZONE

SPECIES	MAY_QZ1	MAY_QZ2.1	MAY_QZ4
L TROUT	279.0	109.0	40.4
B TROUT	6.9	5.5	1.8
Y PICKEREL	0.0	11.6	86.9
N PIKE	0.0	29.7	7.7
SM BASS	0.0	4.5	6.9
Y PERCH	1.8	118.4	151.4
R BASS	3.5	67.5	50.6
W PERCH	8.2	5.5	115.0
L WHITEFISH	1.0	0.6	6.0
R WHITEFISH	12.0	0.0	0.0
SMELT	0.6	0.3	0.0
L HERRING	20.3	0.3	0.0
CW SUCKER	9.7	4.4	11.6
SUNFISH	0.0	0.0	0.2
SPORT TOTS	285.9	160.3	143.7
COMM TOTS	57.1	197.0	334.8
ALL TOTS	343.0	357.3	478.5

LB. CAUGHT BY LOFU DURING JUNE IN EACH QUOTA ZONE

SPECIES	JUN_QZ1	JUN_QZ2.1	JUN_QZ4
L TROUT	92.4	41.3	6.0
B TROUT	0.0	0.0	5.0
Y PICKEREL	0.0	8.8	266.7
N PIKE	0.0	10.0	29.2
SM BASS	0.0	30.5	34.2
Y PERCH	27.2	309.4	93.5
R BASS	8.0	124.1	82.1
W PERCH	3.5	15.5	112.6
L WHITEFISH	0.7	0.0	0.0
R WHITEFISH	1.0	0.0	0.0
SMELT	0.0	0.0	0.0
L HERRING	51.5	0.7	0.0
CW SUCKER	18.0	3.2	35.6
SUNFISH	0.0	0.0	0.2
SPORT TOTS	92.4	90.6	341.1
COMM TOTS	109.9	452.9	324.0
ALL TOTS	202.3	543.5	665.1

LB. CAUGHT BY LOFU DURING EACH MONTH ALL QUOTA ZONES COMBINED

SPECIES	MAY_TOT	JUN_TOT	MAYJUN_TOT
L TROUT	428.4	139.7	568.1
B TROUT	14.2	5.0	19.2
Y PICKEREL	98.5	275.5	374.0
N PIKE	37.4	39.2	76.6
SM BASS	11.4	64.7	76.1
Y PERCH	271.6	430.1	701.7
R BASS	121.6	214.2	335.8
W PERCH	128.7	131.6	260.3
L WHITEFISH	7.6	0.7	8.3
R WHITEFISH	12.0	1.0	13.0
SMELT	0.9	0.0	0.9
L HERRING	20.6	52.2	72.8
CW SUCKER	25.7	56.8	82.5
SUNFISH	0.2	0.2	0.4
SPORT TOTS	589.9	524.1	1114.0
COMM TOTS	588.9	886.8	1475.7

LB. CAUGHT BY LOFU DURING MAY AND JUNE IN EACH QUOTA ZONE

SPECIES	MAYJUN_QZ1	MAYJUN_QZ2.1	MAYJUN_QZ4
L TROUT	371.4	150.3	46.4
B TROUT	6.9	5.5	6.8
Y PICKEREL	0.0	20.4	353.6
N PIKE	0.0	39.7	36.9
SM BASS	0.0	35.0	41.1
Y PERCH	29.0	427.8	244.9
R BASS	11.5	191.6	132.7
W PERCH	11.7	21.0	227.6
L WHITEFISH	1.7	0.6	6.0
R WHITEFISH	13.0	0.0	0.0
SMELT	0.6	0.3	0.0
L HERRING	71.8	1.0	0.0
CW SUCKER	27.7	7.6	47.2
SUNFISH	0.0	0.0	0.4
SPORT TOTS	378.3	250.9	484.8
COMM TOTS	167.0	649.9	658.8

Question 3: What was the marketable proportion of the target yellow perch caught OMNR during the 1987 May and June study?

Answer: This varied by area. Overall, about 52% of the catch was marketable (equal to or over 7 1/2" total length). By quota zone, the results were as follows:

QUOTA ZONE	% MARKETABLE	CUE MARKETABLE
1	76%	18 YP/1000 YDS
2.1	60%	67 YP/1000 YDS
4	41%	45 YP/1000 YDS

The high percent of marketable fish in quota zone 1 may be misleading, as is demonstrated by the comparatively low catch rate of only 18 yellow perch for each 1000 yards of gill net fished per night, and reflects the fact that perch stocks in quota zone 1 are badly over fished.

Question 4: How similar was LOFU's simulated commercial fishery to the commercial fishery run by licensed commercial fishermen during May and June?

Answer: If the two fisheries were comparable, then LOFU should be able to predict the weight of commercially caught yellow perch by combining LOFU catch rates with the expended effort reported by the commercial fishermen. Doing this produces the following results:

MONTH	QUOTA ZONE	LOFU ESTIMATE	COMMERCIAL FISHERMEN'S REPORTS
MAY	1	0 LB	0 LB
	2.1	1130 LB	2670 LB
	4	1766 LB	1857 LB
JUNE	1	244 LB	235 LB
	2.1	5244 LB	4054 LB
	4	307 LB	440 LB
TOTAL	ALL	8691 LB	9256 LB

Statistically, these catches are not significantly different. The 0 value for May in quota zone 1 reflects the fact that there was no effort at this time.

A second way to compare these fisheries is to examine the geographic distribution of effort. The commercial data were taken from the commercial fishermen's monthly reports (CF1's). These distributions were found to be comparable.

As part of its annual commercial catch sampling program, LOFU staff conduct dock side interviews and collect a range of data such as the number of yards of net set, set locations, the number of nights fished, the weight of the harvest, species composition, length frequencies of selected species and so on. During May and June of 1987, six samples were collected as part of this program. These data were used to standardize effort between the simulated fishery and the licensed commercial fishery. In addition, we compared the reported depths fished between the two fisheries and found them to be comparable.

Some discrepancies were observed between the effort and harvest information contained in the CF1's and these same data as reported by the fishermen to the LOFU samplers at the docks where the fish are landed.

We conclude by adding the caution that care must be taken when making comparisons on so few samples.

Question 5: **What are our estimates of the catch by weight (lb.) for all species likely to be caught by the commercial fishery during May and June of 1987?**

Answer: These were estimated in the same manner just described for yellow perch in the previous question. The catch per unit effort (CUE), expressed as LB. of each different species caught per thousand yards of net fished by LOFU was multiplied by the standardized effort reported by the commercial fishermen on their CF1 monthly reports. The expression 'standardized effort' simply means that the effort was expressed as thousands of yards of small mesh gill net fished per night. The results in LB. are shown in the following tables:

Question 5 - cont'd

ESTIMATED CATCH IN LB. BY COMMERCIAL FISHERY DURING MAY OF 1987 FOR EACH QUOTA ZONE

SPECIES	MAY_QZ1	MAY_QZ2.1	MAY_QZ4
L TROUT	0	1036	463
B TROUT	0	53	20
Y PICKEREL	0	108	1016
N PIKE	0	289	88
SM BASS	0	43	80
Y PERCH	0	1130	1766
R BASS	0	646	584
W PERCH	0	52	1234
L WHITEFISH	0	5	69
R WHITEFISH	0	0	0
SMELT	0	2	0
L HERRING	0	2	0
CW SUCKER	0	43	133
SUNFISH	0	0	2
SPORT TOTS	0	1529	1666
COMM TOTS	0	1881	3788
ALL TOTS	0	3409	5454

ESTIMATED CATCH IN LB. BY COMMERCIAL FISHERY DURING JUNE OF 1987 FOR EACH QUOTA ZONE

SPECIES	JUN_QZ1	JUN_QZ2.1	JUN_QZ4
L TROUT	810	700	20
B TROUT	0	0	16
Y PICKEREL	0	149	869
N PIKE	0	168	95
SM BASS	0	580	100
Y PERCH	244	5244	307
R BASS	70	2104	270
W PERCH	30	263	372
L WHITEFISH	6	0	0
R WHITEFISH	9	0	0
SMELT	0	0	0
L HERRING	453	11	0
CW SUCKER	157	55	115
SUNFISH	0	0	1
SPORT TOTS	810	1597	1100
COMM TOTS	970	7678	1064
ALL TOTS	1780	9275	2164

ESTIMATED CATCH IN LB. BY COMMERCIAL FISHERY DURING MAY AND JUNE OF 1987 FOR ALL QUOTA ZONES COMBINED

SPECIES	MAY_TOT	JUN_TOT	MAYJUN_TOT
L TROUT	1499	1531	3029
B TROUT	73	16	89
Y PICKEREL	1124	1017	2141
N PIKE	376	263	639
SM BASS	122	680	803
Y PERCH	2896	5795	8691
R BASS	1230	2444	3674
W PERCH	1286	666	1952
L WHITEFISH	74	6	81
R WHITEFISH	0	9	9
SMELT	2	0	2
L HERRING	2	464	467
CW SUCKER	176	327	502
SUNFISH	2	1	3
SPORT TOTS	3195	3508	6702
COMM TOTS	5669	9711	15380

ESTIMATED CATCH IN LB. BY COMMERCIAL FISHERY DURING MAY AND JUNE OF 1987 FOR EACH QUOTA ZONE

SPECIES	MAYJUN_QZ1	MAYJUN_QZ2.1	MAYJUN_QZ4
L TROUT	810	1736	483
B TROUT	0	53	36
Y PICKEREL	0	257	1884
N PIKE	0	457	183
SM BASS	0	623	180
Y PERCH	244	6374	2073
R BASS	70	2750	854
W PERCH	30	315	1606
L WHITEFISH	6	5	69
R WHITEFISH	9	0	0
SMELT	0	2	0
L HERRING	453	14	0
CW SUCKER	157	97	248
SUNFISH	0	0	3
SPORT TOTS	810	3126	2766
COMM TOTS	970	9558	4852

Question 6: **The target commercial species is yellow perch. What are the estimated proportions by weight of sport fish and yellow perch in the overall catch?**

Answer: **These vary by month and quota zone as shown below:**

MONTH/QUOTA ZONE	% SPORT FISH	% YELLOW PERCH	% OTHER SPECIES
MAY QZ 1	---	---	---
MAY QZ 2.1	45%	33%	22%
MAY QZ 4	31%	32%	37%
JUNE QZ 1	46%	14%	40%
JUNE QZ 2.1	17%	57%	26%
JUNE QZ 4	51%	14%	35%
MAY/JUNE QZ 1	46%	14%	40%
MAY/JUNE QZ 2.1	25%	50%	25%
MAY/JUNE QZ 4	36%	27%	37%
MAY QZ 1, 2.1 & 4	36%	33%	31%
JUNE QZ 1, 2.1 & 4	27%	43%	30%
MAY/JUNE QZ 1, 2.1 & 4 ...	30%	39%	31%

Overall, 30% of the weight of the estimated harvest from small mesh gillnets consists of sport fish, while 39% are yellow perch and 31% are other species. In terms of location, sport fish comprise the greatest proportion of the catch in quota zone 1, and the smallest proportion of the overall catch in quota zone 2.1. Sport fish catches in May are higher than during June.

Question 7: What percentage of sport fish caught during this study could have been released alive?

Answer: The proportion of fish which can be released alive varies according to a variety of factors. Individual fishing methods, the length of time the nets are set, the time of year, how the fish are handled, and the susceptibility of each fish species will influence the opportunity for post capture release and survival. Very few fish are still alive after being in gill nets for 48 hours or more.

Great Lakes Fisherv Commission
Lake Ontario Committee
Gananoque. Ontario
March 7. 1988

Surveillance Report for:

LAKE TROUT REHABILITATION IN LAKE ONTARIO. 1987

bv

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ABSTRACT

Survival rates of adult lake trout exceeded 65% in 1987, meeting the goal of the Joint Plan. Average age of mature females increased from 5.9 years in 1986 to 6.3 years in 1987. Reductions in mortality from both sea lamprey predation and angling contributed to the improved adult survival. Estimates of lake trout carcass density (sea lamprey induced mortality) remained at low levels in 1987, and harvest of lake trout in U.S. waters was unchanged since 1984, but is expanding in Canadian waters. A reduction in post-stocking survival to age 2, slower growth of adults, and older age at sexual maturity were all associated with the expansion of the adult lake trout population. The incidence of stage A1 sea lamprey marks in September was correlated (r=0.946) with density of lake trout carcasses during October-December. Yearling lake trout stocked in May survived better than those planted earlier (excepting Niagara) and fish stocked from shore and by helicopter survived equally well (excepting Eastern Basin sites). Growing 20% more yearlings per raceway did not contribute to more age 2 fish. Naturally deposited eggs were collected with traps at Stony Island shoal in the fall of 1987; more widespread use of egg traps could greatly improve knowledge of where lake trout spawn.

RECOMMENDATIONS

1. Initiate a major cooperative fry collection and genetic assessment program at several shoals within the Eastern Basin of Lake Ontario.

2. Expand egg trapping to Charity, Yorkshire, Pigeon and Scotch Bonnet shoals.

3. Continue cooperative, international assessment programs and consider implementing a lakewide program to assess recreational fishing.

4. Use stage A1 wounds for the marks-of-the-year statistic.

5. Continue to improve stocking and rearing methods.

6. Update the Joint Plan for the Rehabilitation of Lake Trout in Lake Ontario.

INTRODUCTION

Reconstruction of a naturally reproducing population of lake trout is the focus of a major international rehabilitation effort in Lake Ontario. Coordinated through the Lake Ontario Committee of the Great Lakes Fishery Commission, representatives from many cooperating agencies developed a JOINT PLAN FOR THE REHABILITATION OF LAKE TROUT IN LAKE ONTARIO (Schneider, Kolenosky and Goldthwaite 1983), which identified a goal, an interim objective and several strategies for their achievment:

GOAL

"To rehabilitate the lake trout population of Lake Ontario such that the adult spawning stock(s) encompassses several year classes, sustains itself at a relatively stable level by natural reproducion, and produces a usable annual surplus."

OBJECTIVE

"By the year 2000, develop a Lake Ontario lake trout stock consisting of 0.5 to 1.0 million adult fish with females that average 7.5 years of age and produce 100,000 yearlings annually."

To attain these objectives, four broad strategies were formulated:

1. Annually stock 2.5 million yearlings of Lake Ontario strain(s).
2. Maximize recruitment of stocked fish.
3. Maintain annual survival of adults at 60 to 65%.
4. Maximize reproductive potential of lake trout.

Most U.S. fish stocked since 1980 have been tagged with coded wire tags (CWT); in 1988 all Canadian fish stocked will also receive coded wire tags. Lake Ontario strain refers to progeny of lake trout from eggs collected from ripe fish in Lake Ontario.

These strategies not only provide program direction, but they afford the basis for this report. Activities conducted by various agencies during 1987 will be described and then related to specific portions of the Joint Plan.

ASSESSMENT METHODS

ADULT GILL NETTING:
In September 1987 the New York Department of Environmental Conservation (DEC), the United States Fish and Wildlife Service (FWS) and the Ontario Ministry of Natural Resources (OMNR) completed the third lakewide cooperative gill netting survey of adult lake trout in Lake Ontario. Twenty-seven locations were visited by the R/V's SETH GREEN (DEC) and KAHO (FWS); 17 in U.S. waters and 10 in Canada. A total of 2,389 lake trout were captured from 108 lifts of graded mesh gill nets. See appendix I of Schneider et.al. (1987) for details of all major sample designs.

CREEL CENSUS:
The OMNR and DEC conducted direct contact creel surveys of the open lake fishery in Lake Ontario from spring through the fall in 1987. The Canadian census encompassed the area from the Niagara River to Coburg and the U.S. survey included the area from the Niagara River to Henderson Harbor. Both surveys were directed toward boat fishermen with boat trips used as the primary unit of effort; boat counts were made at boat access locations and interviews were based on completed trip information. U.S. agents completed 10,653 interviews and examined 9,566 fish, of which 2,562 were lake trout. Canadian survey crews completed 5,209 interviews, examined 3,909 fish including 248 lake trout. For more details on survey methodology and results see separate agency reports (Stewart 1988; Eckert and Schneider 1987).

JUVENILE TRAWLING:
During July-August 1987 the R/V's KAHO and SETH GREEN made 100 trawl hauls at 14 locations, capturing 1,121 lake trout. An additional 1,450 lake trout were collected with bottom trawls during surveys for alewives (April-May), rainbow smelt (June), and slimy sculpins (October).

CARCASS SURVEY:
The R/V'S SETH GREEN and KAHO swept 393 ha (970 acres) of lake bottom in U.S. waters of Lake Ontario from September through December 1987. Most effort was concentrated at four sites; Olcott, Rochester, Oswego and the Eastern Basin; and in three depth strata: 30-99, 100-159 and >160m. A total of 30 identifiable lake trout carcasses were recovered. Six additional carcasses were collected earlier in the year during other bottom trawl surveys.

FRY COLLECTIONS:
Between April 4 and May 11, 1987 Cornell University (CU) fished 98 emergent fry traps around Stony Island. The traps captured 7 naturally produced sac and emergent lake trout fry. Traps were checked every 1 to 6 days, except during April 19-May 2 when weather conditions prevented visits to the study site. Thirty fry traps were placed on Charity Shoal on May 22, adjacent to and south of the lighthouse marking the shoal. These traps were lifted on June 1 and produced no fry.

EGG TRAPPING:
At Stony Island from October 13 to November 24, 1987, Cornell University deployed 25 plastic pans set in substrate and 24 egg nets set on bottom inorder to collect naturally spawned lake trout eggs. The pans were dislodged by severe weather conditions, but the traps collected 1,008 eggs, which are now being cultured at Cornell University.

EGG COLLECTIONS FOR PROPOGATION:
From November 2 to November 13, 1987 the R/V SETH GREEN fished 8.3 km (5.2 miles) of small mesh gill net at ten locations in the Eastern Basin of Lake Ontario. A total of 2,332 lake trout were captured; 248 ripe females yielded 835,585 eggs (3,365 eggs per fish). Eggs are presently being cultured at the Allegheny National Fish Hatchery (FWS).

RESULTS

STRATEGY 1: STOCKING

Since native stocks of lake trout in Lake Ontario are extinct, the major focus of our rehabilitation effort is the establishment of a new Lake Ontario strain(s). This entails rearing and introducing 2.5 million yearlings of various genetic stocks (1.25 million per nation), assessing strain performance, and emphasizing the use of progeny of lake trout that survived to maturity in Lake Ontario.

Numbers stocked in 1987 reached an all time high: 964,740 and 1,088,389 yearling equivalents in U.S. and Canadian waters, respectively (Figure 1). Five genetic strains of lake trout were stocked in 1987; Killala, Superior, Manitou, Jenny and Seneca Lake strains made up 36.5%, 19.5%, 17.8%, 13.6% and 12.6% of the total (Figure 2). This was the first year that more fish were stocked in Canadian waters. The general pattern to stocking within the last several years has been rapid expansion in Canadian waters and a modest reduction in U.S. waters. The lower number of yearling equivalents planted in U.S. waters in 1987 resulted from loss of production space at the Allegheny National Fish Hatchery. In the last few years more space was allocated for the maintenance of Seneca and Ontario broodstocks, so future production should be similar to 1987.

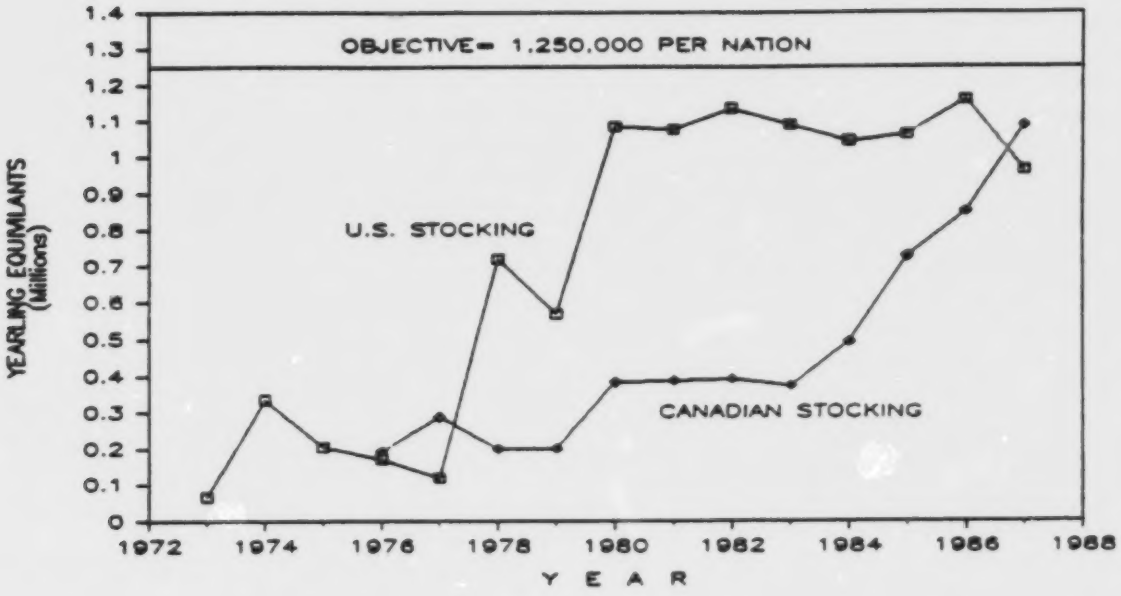

FIGURE 1. Lake trout stocking in the Canadian and U.S. waters of Lake Ontario, 1973-1987.

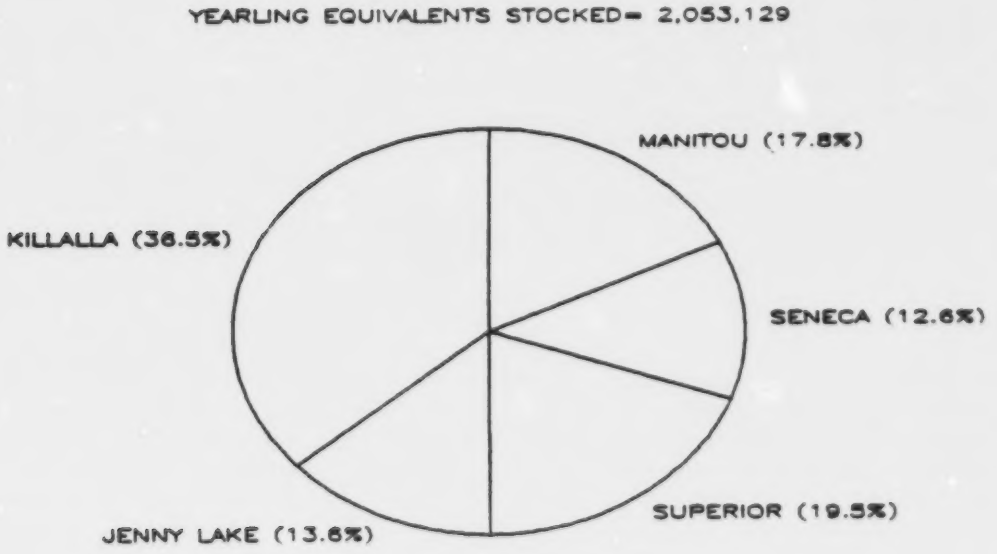

FIGURE 2. Strain composition of lake trout stocked in Canadian and U.S. waters of Lake Ontario during 1987.

STRATEGY 2: MAXIMIZING RECRUITMENT OF STOCKED FISH

The joint plan recommends maximizing recruitment of stocked lake trout by optimizing hatchery rearing practices and stocking techniques. The use of coded wire tags for marking fish has made it possible to initiate studies in U.S. waters to evaluate the effects of rearing density, time of planting, and stocking method on post-stocking survival. While all U.S. lake trout are reared at a single fish culture station, Canadian fish are reared at four different hatcheries, two of which are pond stations. In 1988, all fish stocked by OMNR will be tagged with CWT's, and studies of strain, stocking site, size at stocking and hatchery of origin are being initiated.

Rearing Density:

The standard rearing density of lake trout at Allegheny National Hatchery is 40,000 fish per raceway, but a portion of two year classes were reared at a density of 50,000. Paired releases of yearlings reared at the two densities were made at two locations and at four locations for the 1982 and 1983 year classes, respectively. Recoveries of coded wire tags from samples of fish age 2 and older indicated that for the 1982 year class relative survival of fish reared at the higher density was 96% and 95% of those fish reared at the standard density (Figure 3). But for the 1983 year class, survival of the four lots of fish reared at the higher density was only 65, 84, 93, and 75% that of the fish reared at the standard density. The ratio of tags recovered from fish of the 1982 year class reared at the two densities was not different from the ratio stocked; but for the 1983 year class the ratio was significantly different for three pairs.

There was no visible indication at the hatchery or during stocking that fish reared at the higher density were less fit than those reared at the lower density. Mean size of the 1982 year class at stocking was similar for fish reared at the high, 33.5 g (13.5 per lb.), and standard, 34.8 g (13.0 per lb.), densities. However, mean size of the 1983 year class at stocking was smaller for fish reared at the high density, 30.6 g (13.5 per lb.), than those reared at the lower density, 37.3 g (12.2 per lb.). Raceways containing fish of the 1982 year class at the higher density received about 15% greater water flow from September through May than raceways with the lower density. Water flows were the same to all raceways of the 1983 year class. The differential survival for the 1983 year class may not have been due to size at stocking per se, but rather, the smaller size may have been an expression of a subtly-poorer physiological state that resulted from a greater rearing density per unit of water flow.

FIGURE 3. Survival of lake trout reared at 50,000/raceway relative to that of fish reared at 40,000/raceway during the first year following stocking in Lake Ontario.

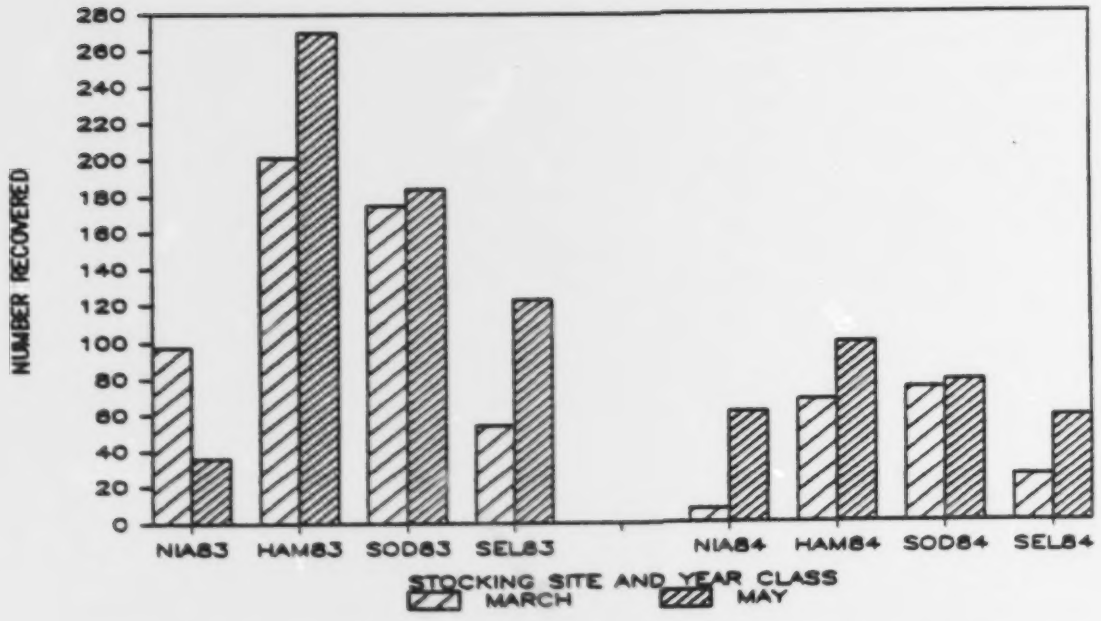

FIGURE 4. Numbers of fish recovered from groups of about 40,000 stocked from shore during March or May at various locations in Lake Ontario.

Planting Time:

Paired releases of yearling lake trout were made at four locations in 1984 and again in 1985 to determine relative survival of fish stocked nearshore in March versus near shore in late May. Results of chi-square analyses of numbers of coded wire tags recovered from fish age 2 and older indicated: (1) relative survival was not different for fish stocked at Sodus (2 pairs), (2) survival of fish stocked in May was significantly higher ($P<0.05$) than those stocked in March at Hamlin Beach and in Mexico Bay (4 pairs), and (3) for fish stocked in the mouth of the Niagara River, survival of the 1983 year class was significantly higher ($P<0.01$) for fish stocked in March than for fish stocked in May, while the reverse was true for the 1984 year class (Figure 4).

Predation by large salmonines may be a major factor responsible for the relatively poor survival of some groups of hatchery-reared lake trout stocked nearshore in spring. Salmon and trout concentrate in many nearshore areas in spring as waters begin to warm, and few alewives are nearshore to provide a buffer against predation on stocked lake trout until June. Concentrations of predators and inshore movement of alewives vary between locations and years; thus relative survival of lake trout stocked nearshore will vary. Nevertheless, fish stocked nearshore in March will always be subject to predation for a longer time than fish stocked in May.

Stocking Method:

Eleven paired releases of yearling lake trout were made in late May 1984-1986 to determine relative survival of fish stocked offshore by helicopter versus those stocked nearshore directly from hatchery trucks. Results of chi-square analyses of the numbers of coded wire tags recovered from fish age 2 and older indicated: (1) relative survival was not different for six pairs, (2) survival of fish stocked by helicopter was higher ($P<0.05$) than those stocked nearshore for four pairs, and (3) survival of fish stocked nearshore was higher ($P<0.01$) for one paired release (Figure 5).

Two of the paired releases for which survival of fish stocked nearshore was poor were made at Dablon Point near the outlet of Lake Ontario, and many of those fish may have been swept down the St. Lawrence River. Fish stocked nearshore would be subject to predation by concentrations of large salmonines as discussed in the preceding section.

STRATEGY 3: MAINTAIN SURVIVAL BETWEEN 60-65%.

Successful rehabilitation of lake trout in Lake Ontario not only requires stocking sufficient numbers and strains of fish, but also demands that enough planted fish survive to produce a viable spawning stock. The Joint Plan prescribes a survival rate of 60 to 65% per annum. To attain

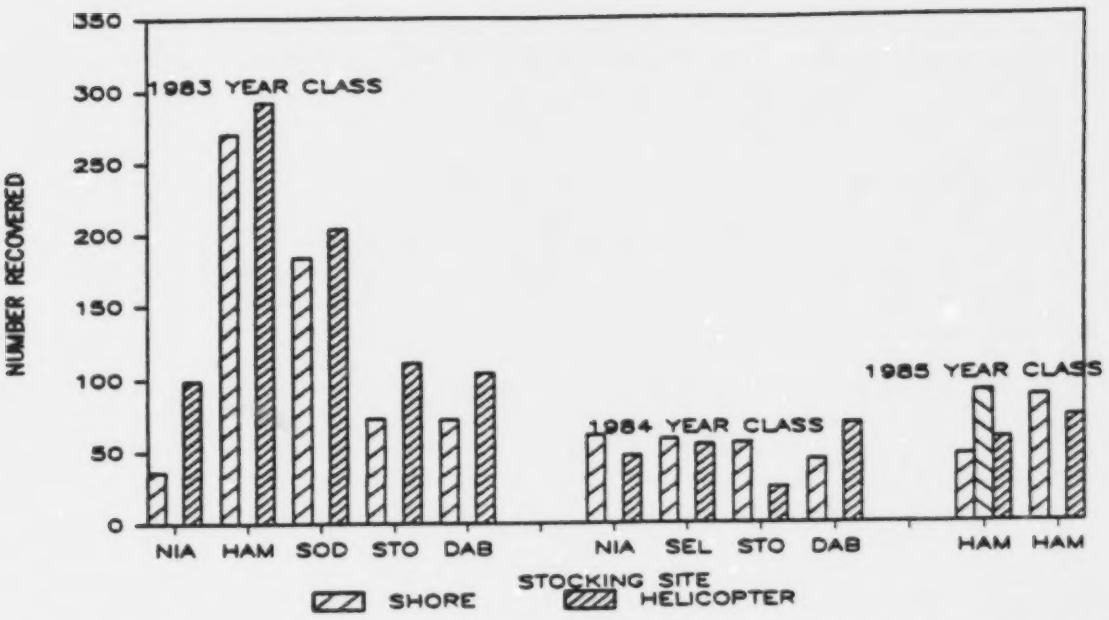

FIGURE 5. Numbers of lake trout recovered from groups of about 40,000 stocked from shore or helicopter at various locations in Lake Ontario.

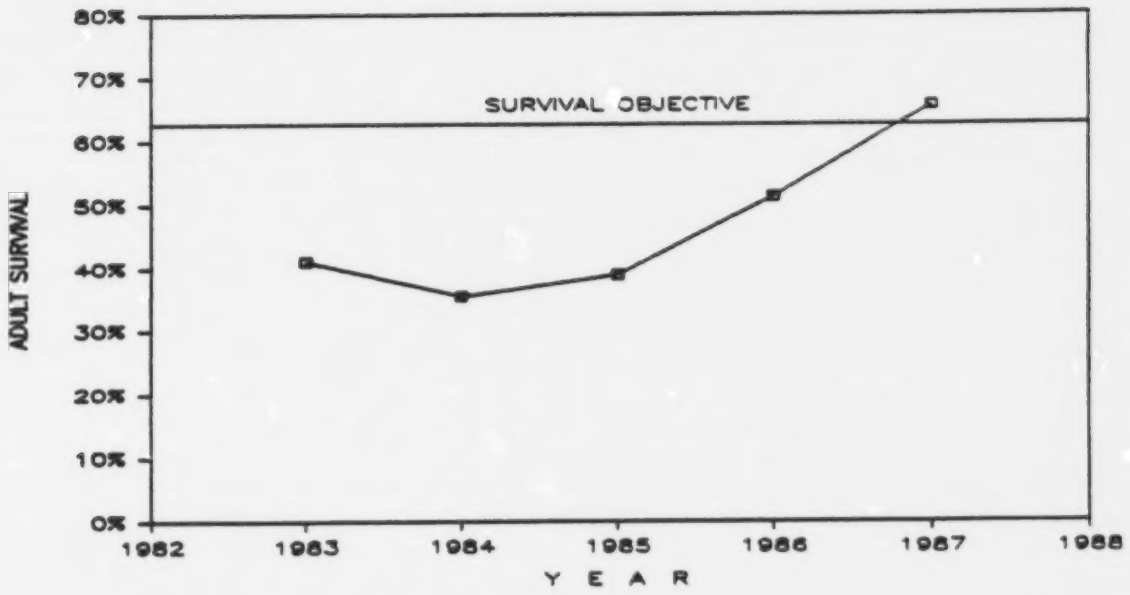

FIGURE 6. Trend in survival of mature lake trout from U.S. waters in Lake Ontario. Estimates from 1983 to 1985 were calculated from gill net relative abundance and the 1986 and 1987 estimates were from creel census CPUE.

this level the plan further suggests that lake trout deaths from sea lamprey should be minimized and exploitation by the fishery should be limited.

TRENDS IN SURVIVAL:

Annual survival of adult lake trout in Lake Ontario during 1983-85 was poor, averaging 36 to 41% (Figure 6), consequently, both OMNR and DEC took steps to improve survival. Incidental capture of lake trout in commercial fishing was a significant component of mortality in Canadian waters, and contributed to OMNR's decision to initiate a commercial gill net buy-out program. In U.S. waters, sportfishing was a major component of mortality and DEC recently instituted more restrictive harvest regulations. Sea lamprey mortality was considered a major mortality factor lakewide, so both OMNR and DEC petitioned the GLFC to provide better lamprey control in Lake Ontario. This in turn led to the experimental treatment of the Oneida Lake system, a potential source of sea lamprey for Lake Ontario. Evaluation of the effectiveness of these corrective measures will focus on changes in lake trout survival.

The primary method for estimating lake trout survival is by comparing relative abundance of the same year class in two successive years, provided that lake trout distribution remains the same from year to year. The sampling design used by DEC-FWS-OMNR accounts to some extent for changes in distribution. Unfortunately, the distribution of lake trout in 1986 was apparently different than in 1985 and the resulting survival estimates based on gill net data were believed to be errroneous (Schneider et.al.1987). Creel survey data, however, was not as problematical and showed that lake trout survival in 1986 improved to 51%.

Data from DEC's creel survey in 1987 showed that the unweighted mean survival for ages 5-8 was 65.6% (Table 1). In 1986, survival was higher for younger age groups than for older lake trout, but in 1987 there was no difference among ages; survival was 64.7% and 65.6% for older and younger fish, respectively. Survival of Clearwater strain lake trout (CWL) was much lower than other strains. This strain frequents shallow water in the spring and prefers depths closer to the thermocline during the summer, and both of these habits make them potentially more vulnerable to angling, and consequently, fewer may survive.

Because gill net abundance estimates were aberrant in 1986, it was not possible to use 1986 data to estimate survival. However, unweighted mean annual survival of fish ages 5-7 derived from the 1985 and 1987 gill net data was 61% (Table 2). This value was intermediate to those estimated from the creel surveys for 1985-86 and 1986-87. This should be the case if both gill net surveys and creel surveys provide valid estimates of abundance at successive ages. Lake trout survival in 1987 met the objectives of the Joint Plan.

TABLE 1. Survival estimates for lake trout collected during DEC's Lake Ontario creel surveys in 1986 and 1987. Survival is 1987 CPUE divided by 1986 CPUE.

			1986			1987				
			FISHING EFFORT= 179,197			FISHING EFFORT= 197,969				
			TOTAL HARVEST= 85,967			TOTAL HARVEST= 89,573				
			C.P.U.E.= 0.4797			C.P.U.E.= 0.4525				
YEAR CLASS	STRAIN	SITE STOCKED	NUMBER	PERCENT FREQ.	C.P.U.E.	NUMBER	PERCENT FREQ.	C.P.U.E.	SURVIVAL (87/86)	WEIGHTED MEAN SUR.
1979	SUP	ALL	55	0.0301	0.0144	38	0.0184	0.0083	57.6%	
		NIA1	10	0.0055	0.0026	4	0.0019	0.0009	33.4%	
		HAM1	9	0.0049	0.0024	8	0.0039	0.0018	74.2%	
		SOD1	2	0.0011	0.0005	8	0.0039	0.0018	333.7%	
		SEL1	4	0.0022	0.0010	4	0.0019	0.0009	83.4%	AGES 7-8= 64.7%
1980	CWL	NIA1	9	0.0049	0.0024	1	0.0005	0.0002	9.3%	
		HAM1	11	0.0060	0.0029	4	0.0019	0.0009	30.3%	
		SOD1	7	0.0038	0.0018	5	0.0024	0.0011	59.6%	
		SEL1	7	0.0038	0.0018	8	0.0039	0.0018	95.3%	
		STO1	6	0.0033	0.0016	9	0.0044	0.0020	125.1%	CWL 6-7= 56.3%
	SEN	STO1	2	0.0011	0.0005	8	0.0039	0.0018	333.7%	
		DAB1	6	0.0033	0.0016	3	0.0015	0.0007	41.7%	
	SUP	ALL	106	0.0580	0.0278	93	0.0450	0.0203	73.2%	
		NIA1	15	0.0082	0.0039	11	0.0053	0.0024	61.2%	
		NIA2	10	0.0055	0.0026	11	0.0053	0.0024	91.8%	
		HAM1	13	0.0071	0.0034	13	0.0063	0.0028	83.4%	
		HAM2	18	0.0098	0.0047	18	0.0087	0.0039	83.4%	
		SOD1	23	0.0126	0.3060	9	0.0044	0.0020	32.6%	
		SOD2	24	0.0131	0.0063	8	0.0039	0.0018	27.8%	
		SEL1	10	0.0055	0.0026	13	0.0063	0.0028	108.4%	
		SEL2	9	0.0049	0.0024	6	0.0029	0.0013	55.6%	SUP 6-7= 66.9%
		STO1	4	0.0022	0.0010	4	0.0019	0.0009	83.4%	
		DAB1	5	0.0027	0.0013	4	0.0019	0.0009	66.7%	AGES 6-7= 66.7%
1981	CWL	ALL	89	0.0487	0.0233	58	0.0280	0.0127	54.4%	
		NIA1	21	0.0115	0.0055	6	0.0029	0.0013	23.8%	
		HAM1	19	0.0104	0.0050	11	0.0053	0.0024	48.3%	
		SOD1	21	0.0115	0.0055	11	0.0053	0.0024	43.7%	
		SEL1	15	0.0082	0.0039	6	0.0029	0.0013	33.4%	
		STO1	13	0.0071	0.0034	8	0.0039	0.0018	51.3%	CWL 5-6= 46.9%
	SEN	DAB1	4	0.0022	0.0010	8	0.0039	0.0018	166.8%	
	SUP	NIA1	29	0.0159	0.0076	25	0.0121	0.0055	71.9%	
		NIA2	13	0.0071	0.0034	11	0.0053	0.0024	70.6%	
		HAM1	44	0.0241	0.0115	38	0.0184	0.0083	72.0%	
		HAM2	34	0.0186	0.0089	33	0.0160	0.0072	81.0%	
		SOD1	26	0.0142	0.0068	23	0.0111	0.0050	73.8%	
		SOD2	26	0.0142	0.0068	33	0.0160	0.0072	105.9%	
		SEL1	19	0.0104	0.0050	18	0.0087	0.0039	79.0%	
		SEL2	19	0.0104	0.0050	18	0.0087	0.0039	79.0%	
		STO1	11	0.0060	0.0029	10	0.0048	0.0022	75.8%	SUP 5-6= 77.6%
		STO2	13	0.0071	0.0034	11	0.0053	0.0024	70.6%	
		DAB1	9	0.0049	0.0024	6	0.0029	0.0013	55.6%	AGES 5-6= 65.6%
?? OTHERS:‡			1,039	0.5681	0.2725	1,444	0.6983	0.3159	na	
TOTALS:			1,829	1.0000	0.4797	2,068	1.0000	0.4525	na	65.9%
									UNWEIGHTED MEAN SURVIVAL (AGES 5-8)=	65.6%

‡ Includes: no clips, no tags, Canadian fish and fish younger than 5 years.

TABLE 2: Relative abundance and survival estimates for lake trout collected during September gill net assessments throughout Lake Ontario in 1985 and 1987.

Survival = $e^{-(\ln(\text{1985 Abundance})-\ln(\text{1987 Abundance})/2)}$

YEAR CLASS	STRAIN	SITE STOCKED	1985 NUMBER	1985 ABUNDANCE	1987 NUMBER	1987 ABUNDANCE	ANNUAL SURVIVAL	WEIGHTED MEAN SUR.
1978	SUP	ALL	11	22,987	3	6,817	54.5%	AGES 7-9
1979	SUP	ALL	104	221,074	37	77,605	59.2%	54.5%
		NIA1	8	6,355	4	3,376	72.9%	
		HAM1	14	29,593	12	21,490	85.2%	
		SOD1	13	21,798	3	3,862	42.1%	AGES 6-8
		SEL1	10	23,947	4	11,245	68.5%	62.3%
1980	CWL	HAM1	30	55,067	4	6,627	34.7%	
		SOD1	26	54,849	6	8,215	38.7%	
		SEL1	19	48,447	3	13,131	52.1%	
		STO1	9	39,978	8	14,438	60.1%	CWL 5-7
		DAB1	9	16,773	3	8,744	72.2%	48.8%
	SEN	STO1	6	32,216	6	5,289	40.5%	SEN 5-7
		DAB1	15	26,845	3	10,939	63.8%	52.4%
	SUP	ALL	111	190,878	60	126,725	81.5%	
		NIA1	7	9,060	6	6,180	82.6%	
		NIA2	9	15,956	9	9,172	75.8%	
		HAM1	25	35,544	11	10,601	54.6%	
		HAM2	19	36,645	10	12,315	58.0%	
		SOD1	24	48,161	11	18,522	62.0%	
		SOD2	23	35,078	10	21,495	78.3%	SUP 5-7
		SEL1	16	38,860	15	27,661	84.4%	72.7%
		SEL2	18	68,113	11	26,388	62.2%	
		STO1	13	27,659	4	17,620	79.8%	AGES 5-7
		DAB1	21	46,919	7	15,149	56.8%	65.9%
TOTALS:			560	1,152,802	250	483,606	64.8%	64.8%
					UNWEIGHTED MEAN SURVIVAL (AGES 5-7)=			60.9%

Average Age of Adult Females:

One of the objectives of the rehabiltation program is to re-establish a suitably sized spawning stock that encompasses several year classes. The average age of mature females was selected as a measure of age composition. Older average ages indicate populations with more age groups and older fish. The current objective for average age is 7.5 years.

The average age of adult females taken in gill nets in U.S. waters increased for the second consequtive year from 5.89 in 1986 to 6.29 years in 1987 (Figure 7). During 1982-85, average age of females slowly declined, presumably due to the large influx of first-time spawners from the large stockings that were begun in 1980. Stocking rates have been relatively stable in U.S. waters since 1980 and most fish from earlier plantings have matured, therefore the recent increases noted in average age of mature females were undoubtedly related to improved survival.

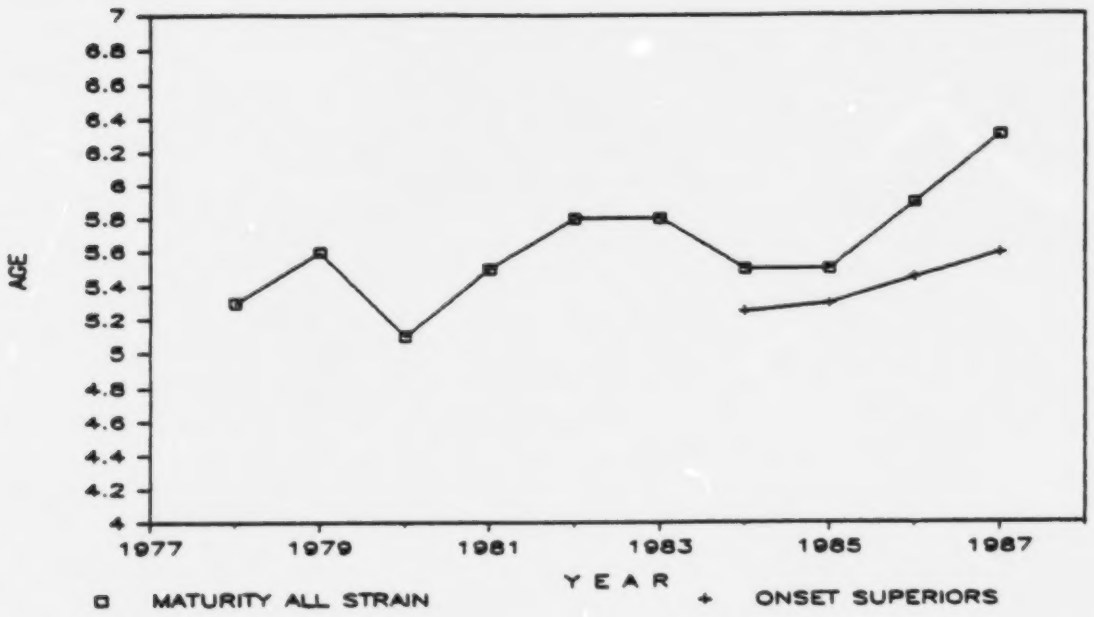

FIGURE 7. Average age of mature female lake trout collected in the U.S. waters of Lake Ontario.

MINIMIZE LOSSES FROM SEA LAMPREY:

Three basic approaches were outlined to minimize sea lamprey predation. First, and foremost, was to maintain adequate control of sea lamprey recruitment through the use of chemicals, barrier dams and/or other means. Increasing prey biomass should ultimately lead to reduced mortality of lake trout, since sea lampreys, under conditions of high density of large prey, are thought to function more like parasites than predators. The third tactic outlined in the plan was to stock genotypes of lake trout that were potentially resistant to sea lamprey induced mortaltiy.

Reduce Sea Lamprey Numbers and Monitor Results:

Sea lamprey control was first initiated in Lake Ontario in 1971. The response of developing stocks of salmonids was dramatic (Pearce et.al. 1980), however, prior to 1986 survival of adult lake trout did not meet plan objectives--it averaged only 35 to 40%. Control agents believed

their efforts should have been more effective, and have initiated studies at other potential sources, such as the Niagara River. Because of poor survival of lake trout and the fact that marking rates on lake trout were consistently higher near the Oswego River (the outlet of Oneida Lake), the Lake Ontario Committee (LOC) recommended experimental sea lamprey treatment of the Oneida Lake system, which was completed the summer of 1984.

To judge the effectiveness of this improved control, the LOC developed an assessment plan that included various decision criteria. The following responses were expected from a successful treatment: (1) improvement in survival for adult lake trout, (2) lower marking rates on surviving lake trout and (3) reduction in lake trout mortality attributable to sea lamprey predation (carcass recoveries). Carcass estimates and marking rates are two methods used to assess sea lamprey induced mortality on lake trout.

Carcass Estimates:

This year was the first occasion that we observed unmarked lake trout carcasses in our September-December trawl surveys; two carcasses had no evidence of any lamprey attack. Nevertheless, most carcasses collected in 1987 (28/30) indicates that the largest component of natural mortality was attributable to sea lamprey, and that most of this mortality occurred in the fall. Carcass density was much less in September and December than in October (Table 3). An October-November summary of carcass density at 30-99m has normally been used for long term, annual comparisons of sea lamprey predation on lake trout. In 1987 carcass density (0.107) at 30-99m depth strata exceeded that at 100-159m (0.079); similar to that measured in 1986. In mid-November, spawning lake trout on Eastern Basin shoals appeared to bear more fresh wounds than those same sized fish taken during September assessment surveys. For this reason addtional carcass trawling effort was completed near these shoals. The December survey, however, showed no evidence of any fresh mortality adjacent to the shoals and overall carcass density was lower than in October. Perhaps, colder than normal fall lake temperatures may have reduced blood consumption by sea lamprey resulting in lower lake trout mortality.

At the 30-99m depth interval, density decreased 63.3%, from 0.169 in 1986 to 0.107 in 1987 (Figure 8). Confidence intervals calculated using the Poisson distribution do not show a statistically significant change in carcass density between 1986 and 1987. The history of these density estimates has been a diminishing, cyclical pattern with low density occurring during odd years.

TABLE 3

DEPTH STRATA (metres)	0-29	30-99	100-159	>160
September				
Carcasses (no.)	--	2	--	--
Area swept (ha)	--	37.0	--	--
Density (no./ha)	--	0.054	--	--
October				
Carcasses (no.)	0	15	3	0
Area swept (ha)	2.9	128.8	36.5	40.0
Density (no./ha)	0.0	0.116	0.082	0.000
December				
Carcasses (no.)	--	6	3	1
Area swept (ha)	--	66.9	39.3	41.1
Density (no./ha)	--	0.090	0.076	0.024
October-December				
Carcasses (no.)	0.0	21	6	1
Area swept (ha)	2.9	195.7	75.8	81.1
Density (no./ha)	0.000	0.107	0.079	0.012
Strata Area (ha)	166,154	203,898	241,192	297,174
Decomposition Rates (days)	--	34	53	57

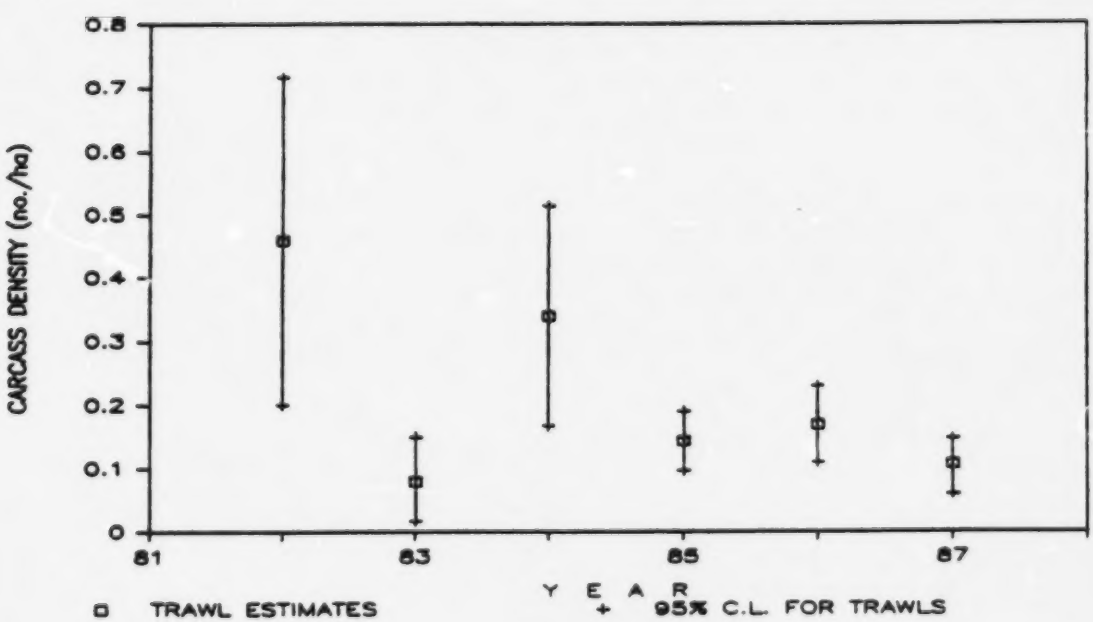

FIGURE 8: Lake trout carcass density and 95% confidence intrvals for U.S. waters between 1982 and 1987.

Estimates of numbers of lake trout killed by sea lamprey from a carcass model (Bergstedt and Schneider, 1986, Schneider et.al., 1987) indicated a continuing decline from 1985 to 1987. Total loss of lake trout attributable to sea lampreys was 111,220 in 1987, reduced 32.2% and 18.4% from 1985 and 1986, respectively (Table 4). Most lake trout carcasses were found at 100-159 m in 1985, however the vast majority were at 30-99 m in 1986 and 1987. The trend in estimated lake trout mortality from the model was somewhat different from that noted in carcass density at the 30-99 m depth strata. This divergence was not unexpected, since the model included two additional depth strata (i.e, 100-159 m and >160 m).

TABLE 4: Estimated numbers of lake trout killed by sea lamprey.

STRATA	Y E A R		
(meters)	1985	1986	1987
30-99	79,574	99,579	68,594
100-159	84,519	18,882	37,192
>160	0	17,758	5,434
TOTAL:	164,093	136,219	111,220

NOTE: 1987 mortality represents that portion attributable to sea lamprey predation (28/30).

Mean age of lake trout carcasses collected during fall surveys increased from 3.5 years in 1982 to 5.5 years in 1986, but then declined somewhat to 5.4 years in 1987 (Figure 9). In 1982, over half of the carcasses recovered were age 3, whereas in 1987 none were age 3. Both the mean and median total lengths of carcasses were larger in 1987 than 1986 (Table 5). This suggests that sea lampreys were selecting older, larger lake trout.

Lake trout mortality from other causes has increased recently. From 1982 to 1984 only one lake trout carcass was captured during summer trawl surveys, while four were recovered in the summer 1986 and six were recovered in 1987. In 1986 and 1987, four deaths were attributed to fishing, one from stocking stress, and the remainder were too decomposed to determine the cause of death.

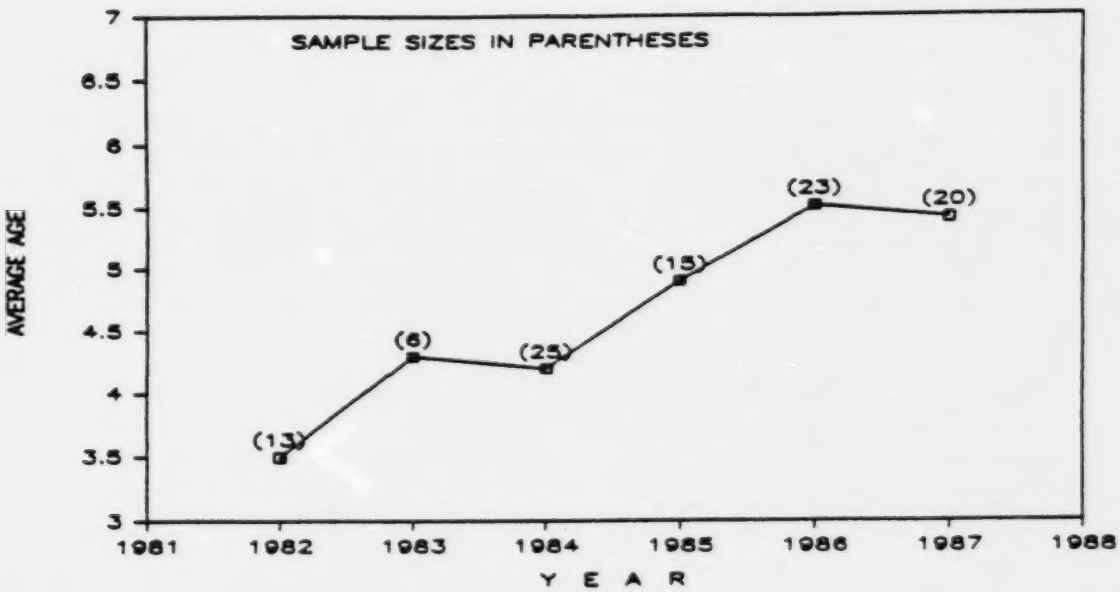

FIGURE 9. Trend in average age of lake trout carcasses collected in U.S. waters of Lake Ontario between 1982 and 1987.

Marks-of-the-year:

Traditionally, lamprey marks on live lake trout were used to indirectly assess lamprey induced mortality on lake trout. It was assumed that high marking levels equated to higher lake trout mortality. Beginning in 1978, lamprey marking data were collected in Lake Ontario employing the criteria developed by King and Edsall (1979). To further standardize reporting of marking statistics, the GLFC (Eshenroder and Koonce 1984) recommended using a mean of wound stages A1, A2 and A3 (A123) as a measure of marks-of-the-year.

Marking statistics based on these recommendations showed a poor relationship to estimates of carcass density. Koonce et.al. (in press; 1987a) reported that "a remaining doubt concerns the lack of a correlation between estimated carcass density and marking rates in New York waters." They believed that observational errors associated with both carcass densities and marking statistics were the most likely cause for the poor relation.

Koonce et.al.(in press; 1987b) indicated that the wound stage data for Lake Ontario indicated a very high fraction of A1 marks, which hinted that most A1 attacks in survey samples were on-going attacks. If this were the case, then A1 marking data collected in September could be more closely associated with fall carcass densities than the A123 marking statistic, which integrates marking rates over a longer period of time. When carcass density at 30-99m depth strata was regressed on marks

per fish, using GLFC recommended wound stages A123, there was no significant relationship (r=0.145, P>0.05, Figure 10); comparable to what Koonce et.al.(in press; 1987a) reported. By eliminating stage A3 wounds from the marking statistic, the resulting relationship between carcass density and A12 marks per fish improved, but was still not significant (r=0.466, P>0.05, Figure 11). When marks per fish included only wound stage A1, the regression of carcass density on marking was highly significant (r=0.946, P<0.001, Figure 12). When this relationship was used to predict carcass density from A1 marks per fish, the density forecasts were within the error bounds of the trawl estimates in 5 of 6 years (Figure 13).

The close fit of carcass density and A1 marking data also suggests that lethality of attack has remained relatively constant. However, we expect that as larger lake trout become more available as prey for sea lamprey, they will survive attacks better than smaller fish, i.e., lethality should decline.

There was a parallel increase in median lengths between carcasses (613-693mm) and A1 wounded fish (628-696mm) from 1983-87 (Table 5). The correlation between median lengths of these two groups was significant (r=0.880, P<0.05 Figure 14); the fit would have been much closer without the inclusion of 1984 (r=0.980), which was a year of much more intensive lamprey predation. Based on these findings we recommend that stage A1 wounds be used in the future.

TABLE 5. Comparison of total lengths from A1 marked fish and carcasses.

	A1 WOUNDS				CARCASSES			
YEAR	MEAN	MEDIAN	MIN	MAX	MEAN	MEDIAN	MIN	MAX
82	606	615	470	775	--	--	--	--
83	615	628	424	750	600	613	488	680
84	637	648	375	800	607	598	430	724
85	644	651	465	793	655	650	540	760
86	664	676	412	787	672	681	492	788
87	696	696	602	772	691	693	562	788

With stronger verification of the relation between carcass density and marking, it was possible to more confidently review past years A1 marks per fish and assess the impact of sea lamprey on lake trout in U.S. waters of Lake Ontario (Figure 15). The marking data supports what was implied by carcass surveys since 1982; that 1983 and 1985-87 were low, while 1982 and 1984 were high. Prior to 1982, the marking data indicated that 1981 was low and other years were near the highest observed. We can probably assume that lake trout mortality from 1985-87 was reduced more than 50% from pre-1981 levels.

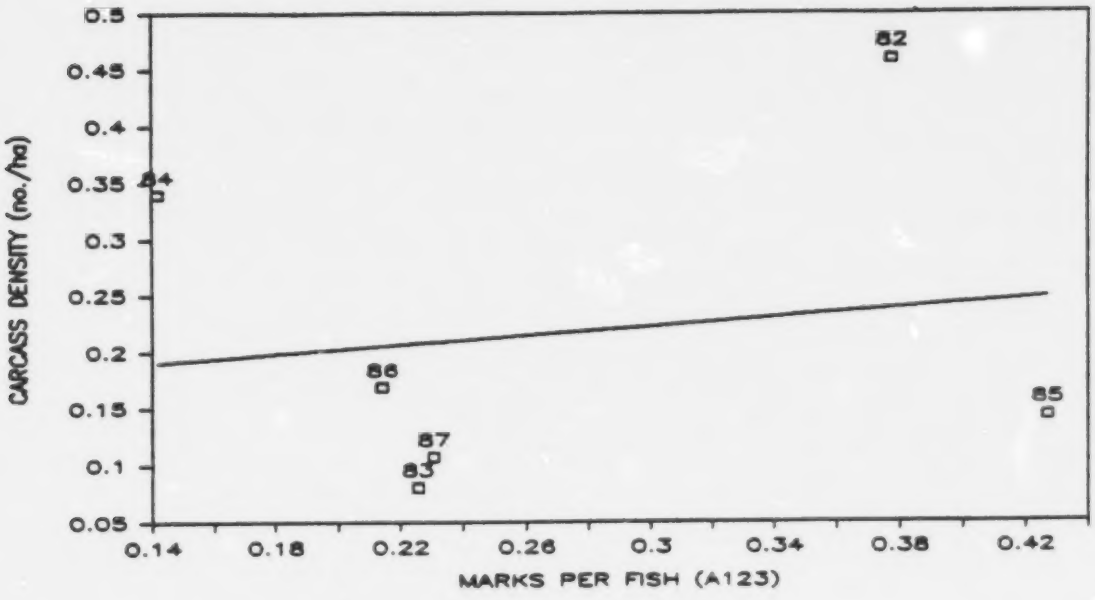

FIGURE 10. Wounding-carcass relationship using wounding stages A1 + A2 + A3 (A123). Marks per fish is the total A123 wounds observed divided by the total lake trout greater than 431 mm examined from U.S. waters of Lake Ontario.

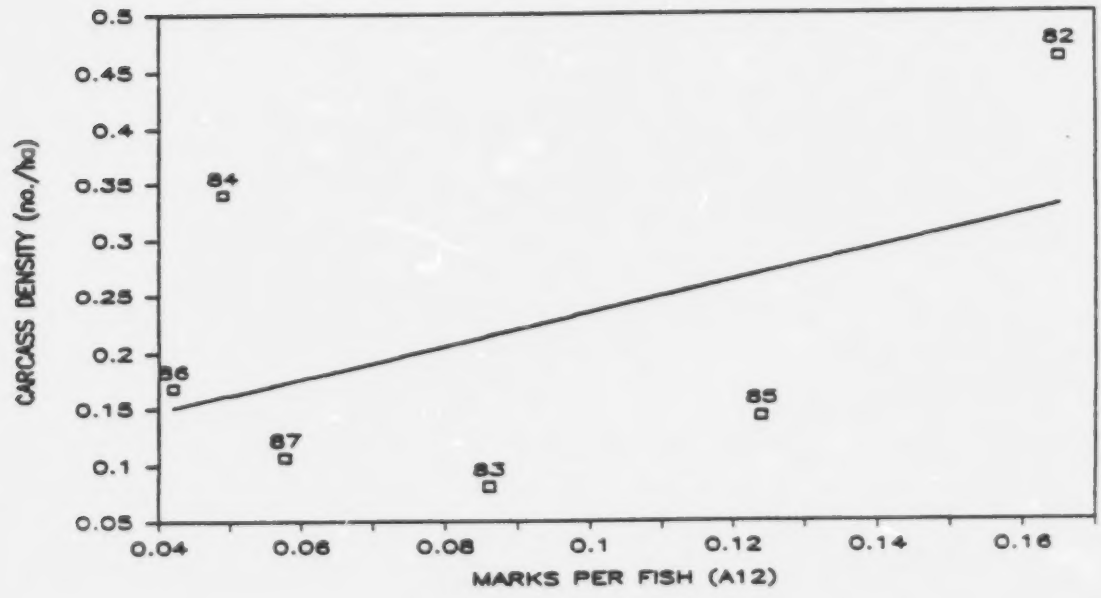

FIGURE 11. Wounding-carcass relationship using wounding stages A1 + A2 (A12). Marks per fish is the total A12 wounds observed divided by the total lake trout greater than 431 mm examined from U.S. waters of Lake Ontario.

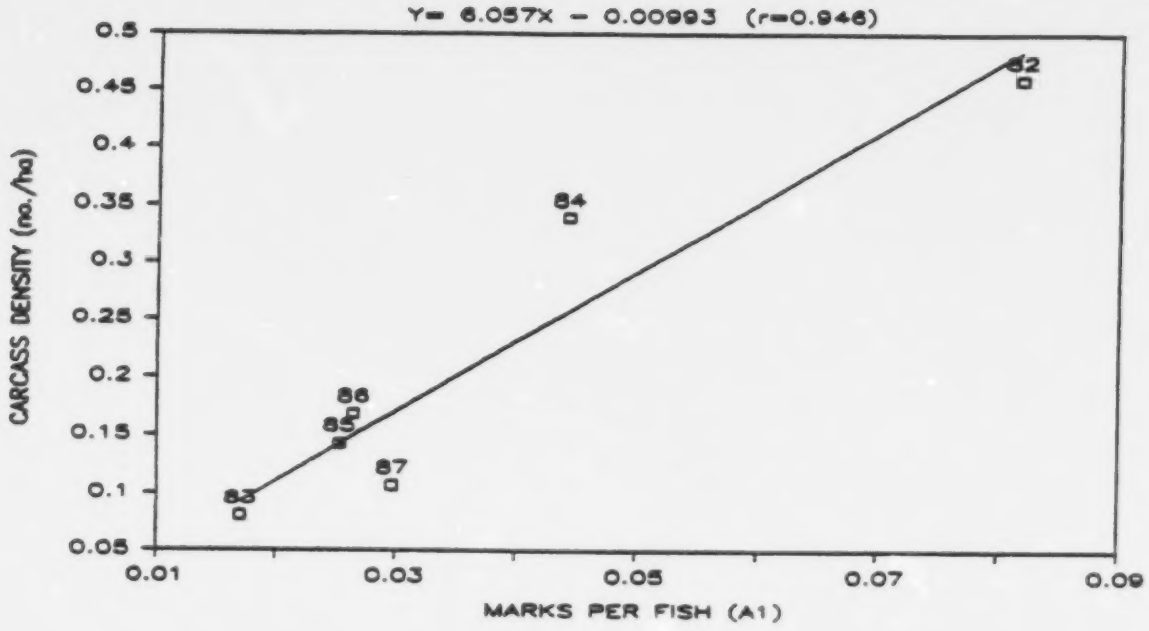

FIGURE 12. Wounding-carcass relationship using wounding stage A1. Marks per fish is the total A1 wounds observed divided by the total lake trout greater than 431 mm examined from U.S. waters of Lake Ontario.

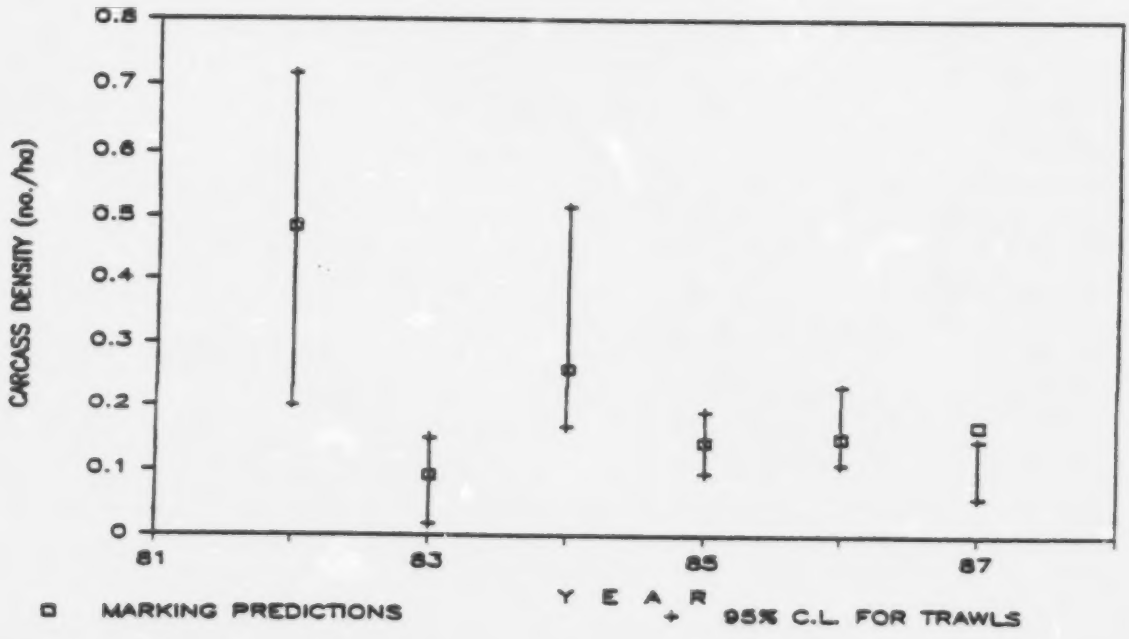

FIGURE 13. Carcass density estimates from A1 marking rates and the A1 marking-carcass density relation (Fig. 12). Vertical bars are the 95% confidence limits from trawl estimates of carcass

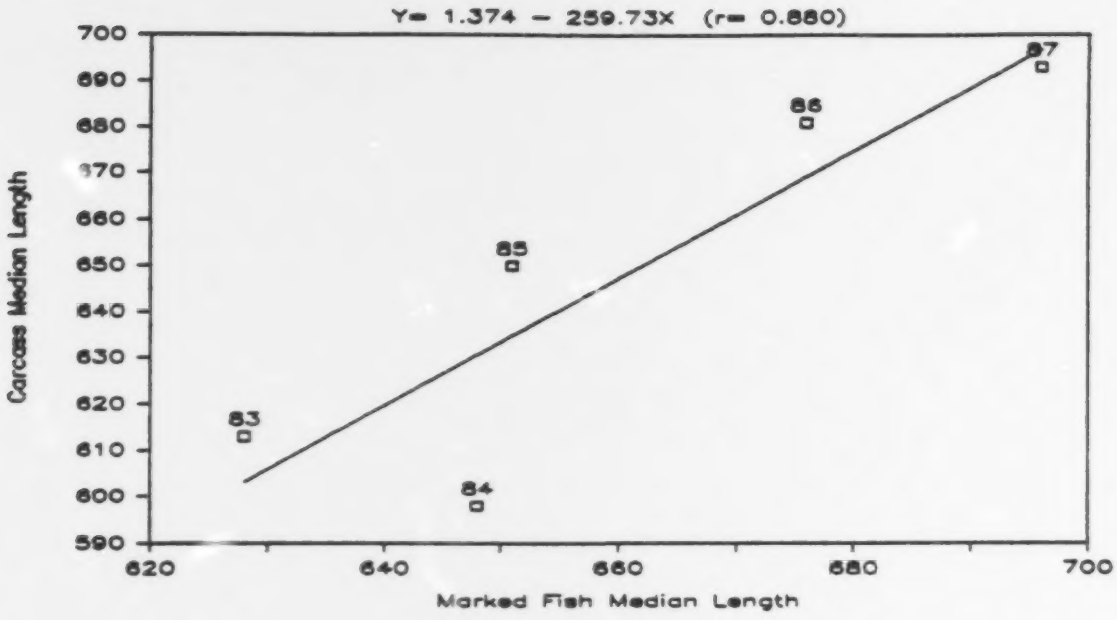

FIGURE 14. Length relation between trawl recovered carcasses and A1 marked lake trout taken in September gill net assessment surveys.

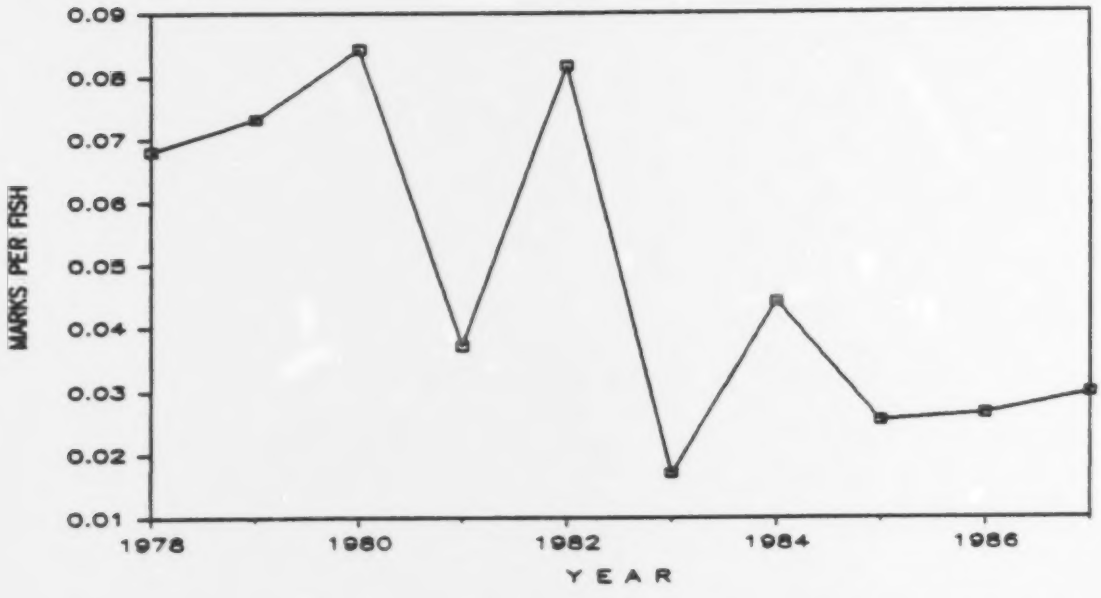

FIGURE 15: Trend in A1 marking in lake trout collected in U.S. waters since 1978.

Increase in Prey Biomass:

The size of the mature lake trout population in Lake Ontario has grown substantially over the last seven years (Figure 16). An abundant population of larger, older lake trout should attract sea lamprey attacks, and these lake trout should in turn be better suited to survive those attacks. In theory, sea lamprey should become true parasites, rather than predators. This concept had enough merit that it was outlined in the Joint Plan.

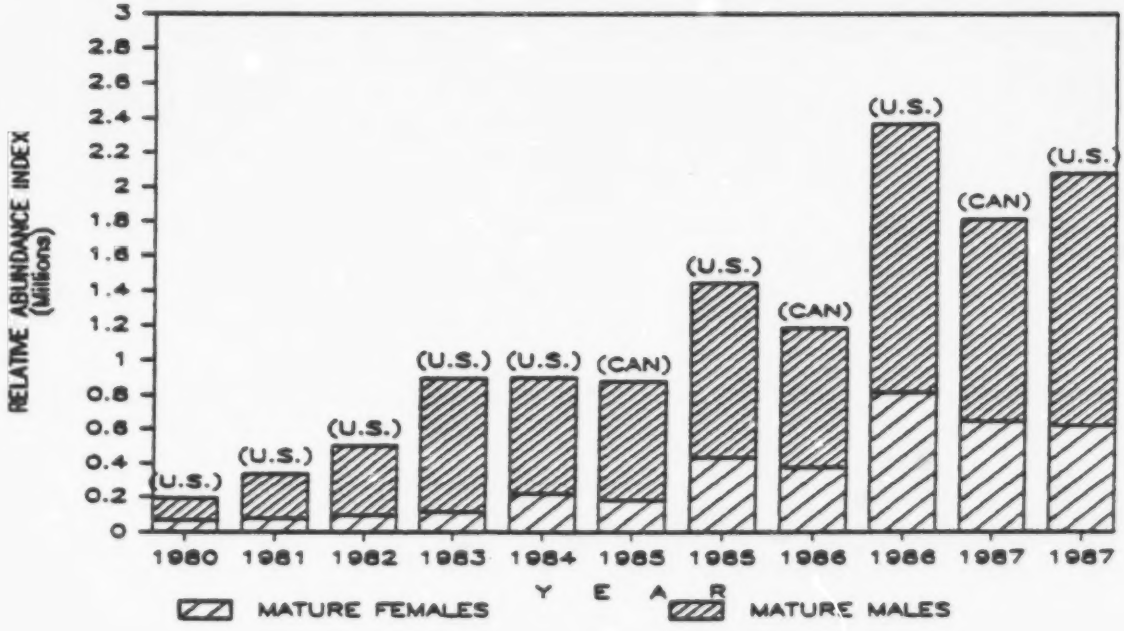

FIGURE 16. Relative abundance of mature lake trout in Lake Ontario between 1980 and 1987.

Lake Trout Genotypes Potentially Resistant to Lamprey:

As discussed in Schneider et al (1987), the Seneca strain of lake trout had fewer wounds and occurred less frequently in the carcass surveys. No additional data are available to address this issue at this time.

LIMIT EXPLOITATION:

Fishing is the other major, controllable component of lake trout mortality in Lake Ontario. Creel survey provides an effective and reliable means for quantifying the number of lake trout killed by fishermen. This information, in conjunction with carcass survey estimates should permit a reasonable assessment of the corrective actions necessary to improve survival.

Canadian and US surveys conducted in 1987 did not sample all fisheries. Neither considered pier or shoreline fishermen, and Canadian surveys did not sample moored boats. The comprehensive US survey conducted in 1984 suggests that U.S. harvest figures for 1985 to 1987 probably represent about 85% of the actual harvest. While a similar bias assessment is not available for Canadian recreational harvest, it is not as important since fewer lake trout are taken in Canadian waters.

Harvest of lake trout by sport fishermen was much more intensive in U.S. waters than the Canadian harvest (Table 6). Considering the growth of fishing effort in U.S. waters, it was surprising that annual harvest did not increase; it remained remarkably consistent at 84,000 to 90,000 lake trout.

Two new major Canadian fisheries developed in 1987, and resulted in an overall 782% increase in the harvest of lake trout (15,077 fish) and a 28% increase in effort (61,703 boat trips; table 6). The western and central basin fisheries are mainly for salmonids, while the eastern basin fishery is mainly a charter boat fishery for lake trout. This is reflected in the HUE's of 0.046, 0.083 and 4.724 respectively, where HUE is expressed as the number of fish harvested per boat trip.

Both of these trends were evident at a time when the fishable portion of the lake trout population was growing.

The dramatic improvement observed in adult lake trout survival in U.S. waters was not only the result of reduced mortality from sea lamprey predation, but also from a substantial decline in exploitation. The abundance of mature lake trout in U.S. waters (Figure 16) was used as an index of the fishable stock, because an inspection of the size distribution of angler catches indicated that this was a reasonable assumption. Dividing harvest by abundance resulted in an index of exploitation (Figure 17), which showed a 62.1% decline from 1984 to 1987. This analysis suggested that fishermen were directing their efforts away from lake trout and were seeking alternative species for harvest, because fishing effort was increasing and more lake trout were available to catch, yet harvest remained stable. If we applied the relative exploitation rate measured in 1984 to the present estimate of the fishable stock (mature trout abundance), harvest would have exceeded 200,000 lake trout. Obviously, reduced exploitation by U.S. anglers contributed to improved survival.

TABLE 6

	Y E A R				%CHANGE
	1984	1985	1986	1987	1986-87
COMPLETED BOAT TRIPS:					
CANADA WESTERN BASIN	na	35,700	48,039	55,447	15.0%
CENTRAL BASIN	-	-	-	3,673	-
EASTERN BASIN	-	-	-	2,583	-
TOTALS	na	35,700	48,039	61,703	28.4%
UNITED STATES	123,814	172,093	179,197	197,969	10.5%
LAKE TROUT HARVEST:					
CANADA WESTERN BASIN	na	2,227	1,710	2,567	50.0%
CENTRAL BASIN	-	-	-	308	-
EASTERN BASIN	-	-	-	12,202	-
TOTALS	na	2,227	1,710	15,077	781.7%
UNITED STATES	89,473	84,366	85,967	89,573	4.2%

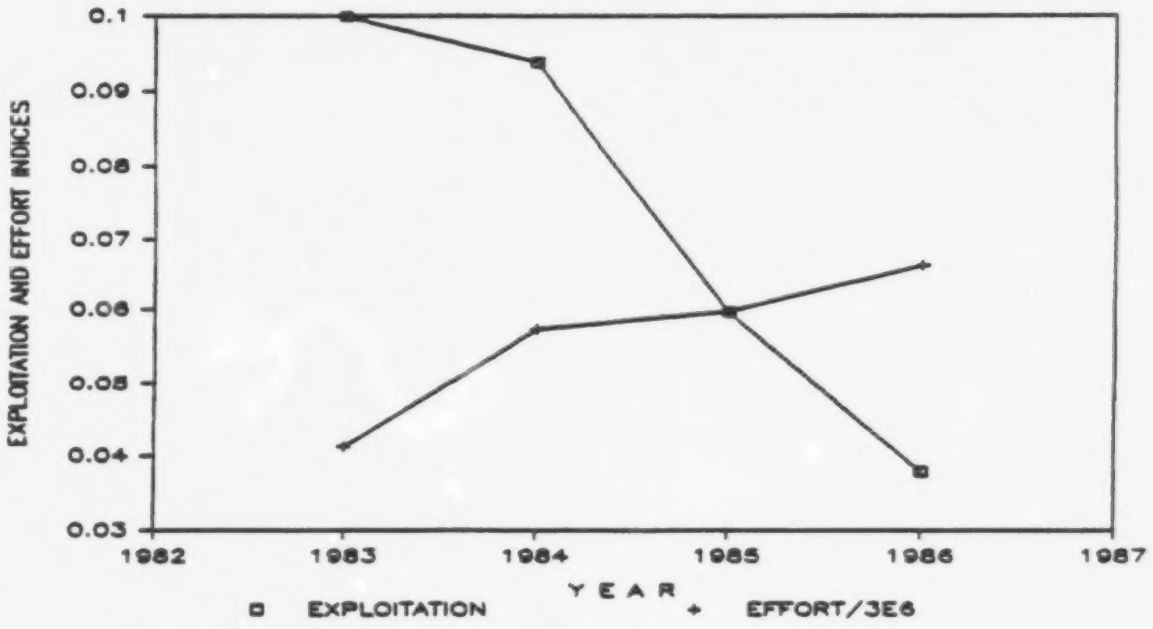

FIGURE 17. Trends in relative exploitation and fishing boat effort for lake trout in U.S. waters of Lake Ontario in 1987. Relative exploitation is harvest divided by gill net abundance index for mature fish from the previous year.

Lake trout by-catches in Canadian gill net fisheries continues to add to lake trout mortality. During May and June of 1987, an estimated 3,029 lbs of lake trout were caught in the yellow perch gill net fishery (Dentry, 1988). During November and December of 1987, a further 8,781 lbs of lake trout were taken by commercial fishermen fishing for lake whitefish. Statistics for the numerous other gill net fisheries operated in 1987 are not available, and our best estimates continue to be those made in 1984. They range from 20,000 lbs to 60,000 lbs per year. Since 1984 we have seen dramatic increases in lake trout stocks as a result of the annual stocking programs, and, as a result of an OMNR byout program, moderate decreases in the amount of gill net which can be fished. U.S. commercial fisheries are much less intensive and localized near the Eastern Basin. By-catch mortality is unknown, but could be appreciable, especially to local spawning stocks.

Overall, the known forms of harvest in both U.S. and Canadian waters are a substantial component of lake trout mortality. Losses of lake trout through illegal commercial and recreational fishing are unknown, but they could be sizable.

STRATEGY 4: MAXIMIZE REPRODUCTIVE POTENTIAL

In the Joint Plan degradation of the ecosystem was not considered a causal agent in the demise of native lake trout, principally because lake trout were declining prior to the period of most intensive eutrophication and contamination. However, habitat quality is now diminished and may hinder rehabilitation. The suggested approach to maximizing reproductive potential of the new Lake Ontario stock involves: (1) improving water and habitat quality, (2) maximizing use of the least degraded spawning and nursery habitat and (3) determining those conditions on the spawning grounds which may be inhibiting successful reproduction.

SPRING FRY COLLECTION:

Ninety-eight fry traps were placed on Stony Island reef between April 4 and May 11, 1987, and remained in position until June 1, 1987. The traps were located in the same area of the reef where 75 fry were captured in April-May 1986. In addition, traps were checked for fry every one to six days, except for the period between April 19 and May 2 when weather conditions prevented our reaching the study site. A total of 7 fry were captured between April 9 and May 2. Eight traps were lost due to severe weather conditions during the latter part of April. Thirty fry traps were placed on Charity Shoal on May 22, adjacent to and south of the lighthouse marking the shoal. These traps were lifted on June 1; no fry were found in the traps. The catch per unit effort on Stony Island in 1987 was 0.002 fry/trap day, compared to 0.04 fry/trap day in 1986.

FALL EGG TRAPPING:

During the period October 13 to November 10, 1987 three types of equipment were deployed on Stony Island reef to collect lake trout eggs:

(1) In early November, forty-five steel pails were set into the substrate and filled with substrate, then capped with mesh lids. Each trap was seeded with 100 eggs from Allegheny National Fish Hatchery. The objectives were: (a) to examine egg survival on different substrate types, and (b) to examine predation.

(2) Four transects of 25 plastic pans, approximately 21x33x5 cm deep and 3.3 m apart, were set into the substrate and filled with substrate. The transects were set on four types of substrate ranging from sand to large cobble; one transect crossed the area where fry were found in 1986. The objective was to determine whether lake trout select substrate types on which to spawn. The pans were dislodged from the substrate by severe weather before spawning began.

(3) Four transects of 25 egg nets were deployed adjacent to the pan transects to evaluate natural egg depostion rates. The nets consisted of a 20 cm diameter ring with a net cone attached; the nets were deployed from the surface in gangs, and recovered from the surface. All transects had to be reset after severe weather; some nets broke loose, but were recovered by divers. This method was effective for collecting eggs (Table 7). The largest number of eggs captured in a single net was 333, which gives a maximum egg density of 1.06 eggs/cm² (6.63 eggs/inch²). A total of 1,008 eggs captured in these nets were placed in a hatchery at Cornell University; 548 eggs were eyed as of December 30, 1987.

TABLE 7

NETS SET	NETS LIFTED	SUBSTRATE TYPE	NUMBER NETS	TOTAL EGGS	# LIVE EGGS	MAX. EGGS/NET
10/13	11/13	LG. GRAVEL	24	261	129	71
10/13	11/13	SAND, SILT	21	3	0	1
11/13	11/24	LG. GRAVEL	23	1830	1023	333

NOTE: An additional 3 nets which had become detached from their lines were recovered on 11/10/87 on sandy substrate. The nets contained 12, 14, and 25 eggs respectively.

EGG COLLECTIONS:

Collecting lake trout eggs from spawning fish was begun by DEC in the 1970's to evaluate the impact of contaminants on egg viability and hatching success. Results of those studies were encouraging,and consequently, DEC and FWS began collecting eggs in 1982 for rearing at the Allegheny National Fish Hatchery. Egg collection activites not only relate to broodstock development, but also, important information can be obtained on the distribution of spawning lake trout. This data, when keyed to habitat surveys, will permit an assessment of whether or not lake trout are using suitable sites and substrates for spawning.

During the fall of 1987, ripe adult lake trout were abundant on several shoals within the eastern basin of Lake Ontario. Between November 2 and 13, 1987, the R/V SETH GREEN made 27 gill net sets totaling 8,338 m (5.2 miles) at 10 separate locations. A total of 2,332 lake trout were captured; of these 248 were ripe females whose eggs were stripped, fertilized and shipped to Allegheny NFH. Ripe females were common at most of these locations. Mean catch of ripe females per 300 m ranged from 6.6 at Point Peninsula to 16.4 at Galloo Spit (Table 8). Few ripe females were captured at the east shore of Galloo Island or at Pillar Pt. At Stony Island, Charity and Allan Otty shoals fewer females and total lake trout were captured in 1987 compared with 1986. However, in 1987 we fished for a longer period of time and not just at peak spawning as we did in 1986, and we used a greater proportion of heavy twine netting in 1987. These factors were probably more related to the decline in catches of spawners.

TABLE 8: Summary of gill net collections of spawning lake trout from Eastern Basin shoals of Lake Ontario. Data values for 1986 are in parentheses.

		MEAN CATCH PER 300m OF GILL NET	
LOCATION	EFFORT LIFTS/m)	TOTAL	RIPE FEMALES
STONY IS.	6/2713	70.6 (115.2)	9.8 (11.8)
CHARITY SHOAL	12/3459	96.7 (193.9)	8.7 (10.8)
PIGEON IS.	2/366	115.7	8.2
GRENADIER IS	2/351	133.6	7.5
GALLOO SHOAL	2/549	132.1	9.4
GALLOO SPIT	1/183	128.0	16.4
GALLOO EAST	1/183	47.6	1.6
ALLAN OTTY	1/168	175.4 (193.9)	7.2 (6.9)
PT. PENINSULA	1/183	37.7	6.6
PILLAR PT.	1/183	26.2	1.6
TOTAL:	27/8338		
WEIGHTED MEAN	na	91.3	8.7

More eggs were shipped to Allegheny NFH in 1987 than in any previous year. 835,585 were taken from 248 ripe females, which represented an average of 3,365 eggs per female, up 13.0% from 1986. This increase in average eggs per female agreed with the observed increase in average age of females from September assessment netting (Figure 7).

Fertilized eggs were shipped to Allegheny NFH every other day, since earlier studies showed that lake trout eggs from Lake Ontario could be shipped 48 hours after stripping without any adverse effects. However, eggs taken in 1986 eyed-up poorly. We attributed this to poor egg quality from many first-time spawners. In 1987 egg quality was expected to improve as the average age of females increased. However, egg quality did not improve. Eggs in some shipments did not eye-up at all, while others did very well (92% eyed). An regression of eye-up and shipping time showed a highly significant regression ($r=-0.91$, $P>0.0001$) indicating that poor eye-up was directly related to the delay in shipping. The discrepancy between this analysis and earlier studies may have been related to age of females, i.e., those from the first study were all 7 to 10 years of age, while the current spawners were mostly 5 and 6 years old. To improve eye-up in future egg takes, eggs should be shipped the day they are taken.

DENSITY DEPENDENT EFFECTS:

The Joint Plan recognized that density dependent population responses could confound the attainment of plan objectives. The plan forecast that as the lake trout population expanded, growth rates would decline, age at maturity would increase, fecundity would be reduced, and natural mortality could increase. These kinds of changes were not intended to forebode a population collapse; instead they are normal responses that should be expected as the population increases.

CHANGES IN GROWTH:

Lake trout condition in Lake Ontario has been steadily declining since 1978. Weight-length regressions were calculated for all lake trout taken in September gill net surveys. These regressions were used to predict the weight of a 600 mm reference length lake trout (Figure 18). The predicted weights showed a highly significant ($P<0.0001$, $r=-0.954$) decline in body weight over the nine year period. Predicted weights were greater in 1987 compared to 1986, but this was not unusual because weights have oscillated regularly during the decline.

Weights of lake trout are now approaching the predicted weight (1995g) of a 600 mm native lake trout from Lake Ontario in 1927. This estimate was derived from a weight-length regression developed from a sample of fish examined by Dymond (1928) and it assumed that the lengths

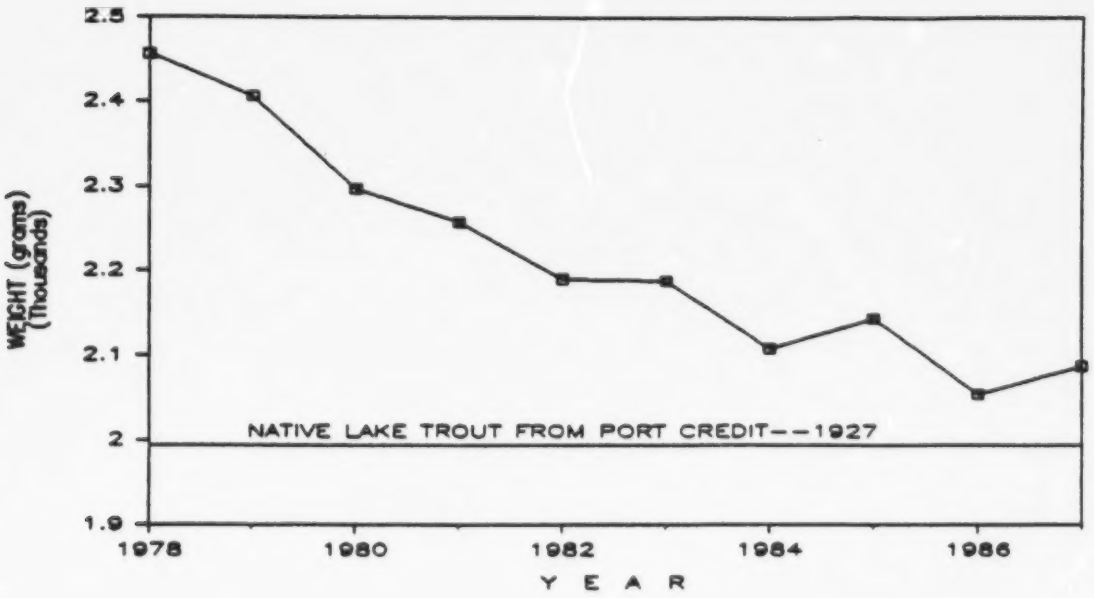

FIGURE 18. Weight of a 600 mm (total lngth) lake trout predicted from length-weight regressions from 1978 to 1987.

provided by Dymond were fork lengths. Previous analyses (Schneider et.al., 1987) indicated that these changes in weight or relative plumpness were not related to different strain effects, and also, there were no corresponding reductions in total length.

MATURITY:

Female lake trout in Lake Ontario are now taking longer to mature. The percentage of Superior strain age 5 females that were mature in 1987 was the lowest observed, 54.1% (Superior strain was used as a reference to eliminate strain effects, Figure 19). The onset of maturity, which is a general measure of the average age of first spawning, has continued to increase since 1984 (Figure 7).

TREND IN SURVIVAL OF YOUNG FISH:

Not only was condition decreasing and maturity increasing, but fewer young lake trout from hatchery plantings were surviving. Catches (per 10,000 fish stocked), at age 2 during the July-August trawl surveys, indicated a recent decline in survival during the first year following stocking. Low catches of fish of the 1982-84 year classes stocked on

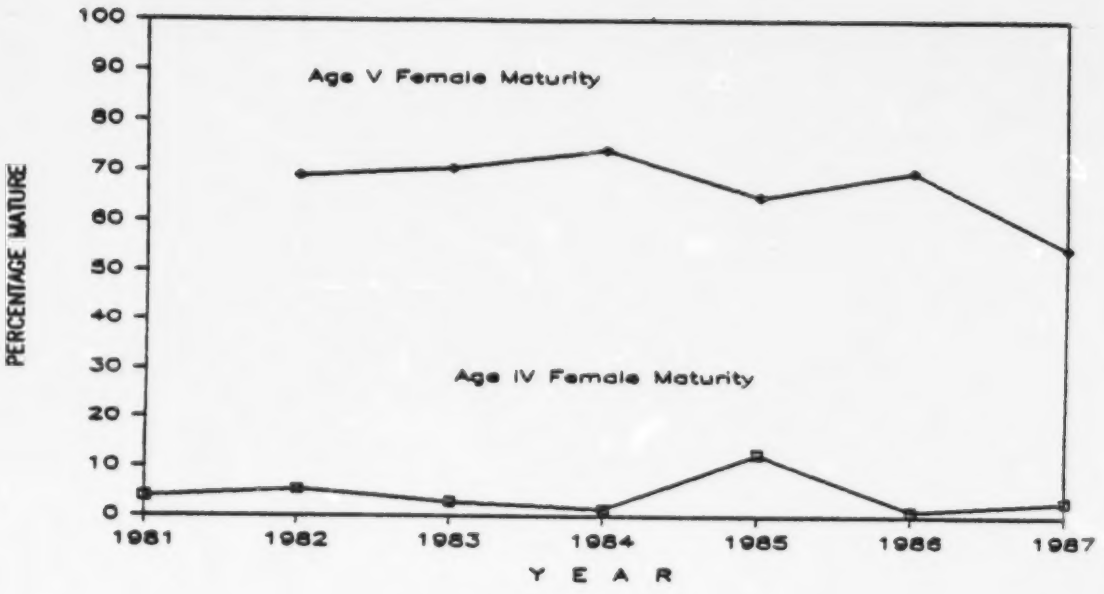

FIGURE 19. Maturity rates for ages 4 and 5 Superior strain females. Collected in Lake Ontario from 1981 to 1987.

the Niagara Bar were attributed to predation on recently stocked fish by concentrations of large trout and salmon. Consequently, the stocking site was moved about 25 km eastward to Olcott, beginning with the 1985 year class. Catches of age 2 fish stocked at Hamlin suggested that first-year survival of the 1985 year class was considerably lower than in previous years (Figure 20). Recoveries of the 1985 year class of Superior strain fish at Hamlin were reduced 47% from the 1979-82 mean. Catches of fish of the 1985 year class were also the lowest observed for fish stocked at Sodus and Selkirk.

The recent expansion of the lake trout and salmon populations has probably built to the point that predation on recently stocked lake trout is now substantial at all stocking sites. Catches of age 2 Superior strain fish stocked at Hamlin were inversely related to adult lake trout abundance ($r=-0.687$, $P<0.05$, Figure 21). There was also a suggestion that recent lower catches of these age 2 fish was related to rearing density. While the regression was not significant ($r=-0.490$, $P=0.108$), the performance of fish reared at high density should be examined more closely in the future.

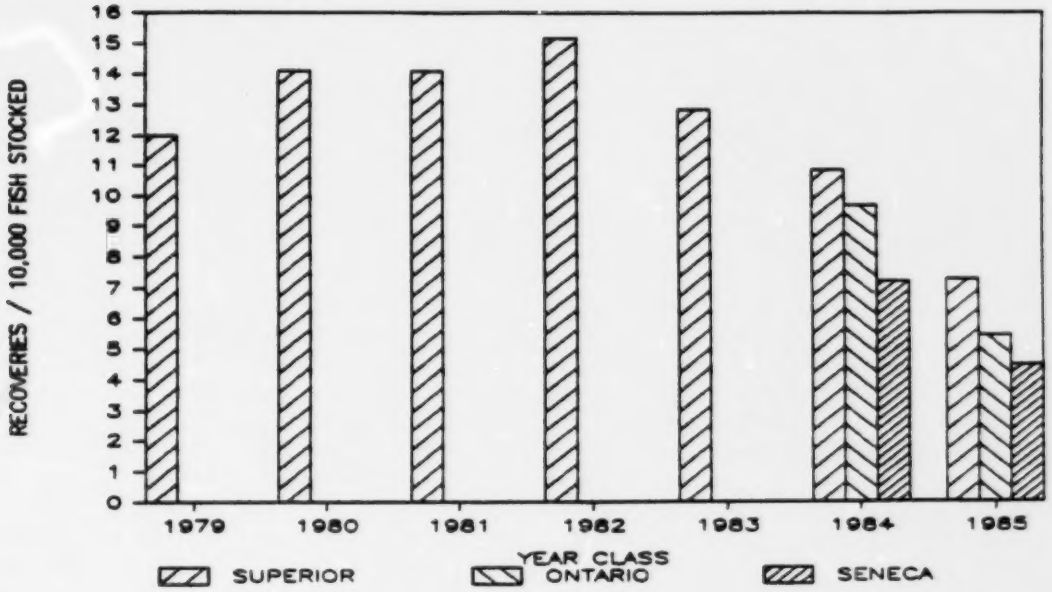

FIGURE 20. Indices of survival of three strains of lake trout stocked as yearlings at Hamlin; based on catches with bottom trawls at age 2 during July and August.

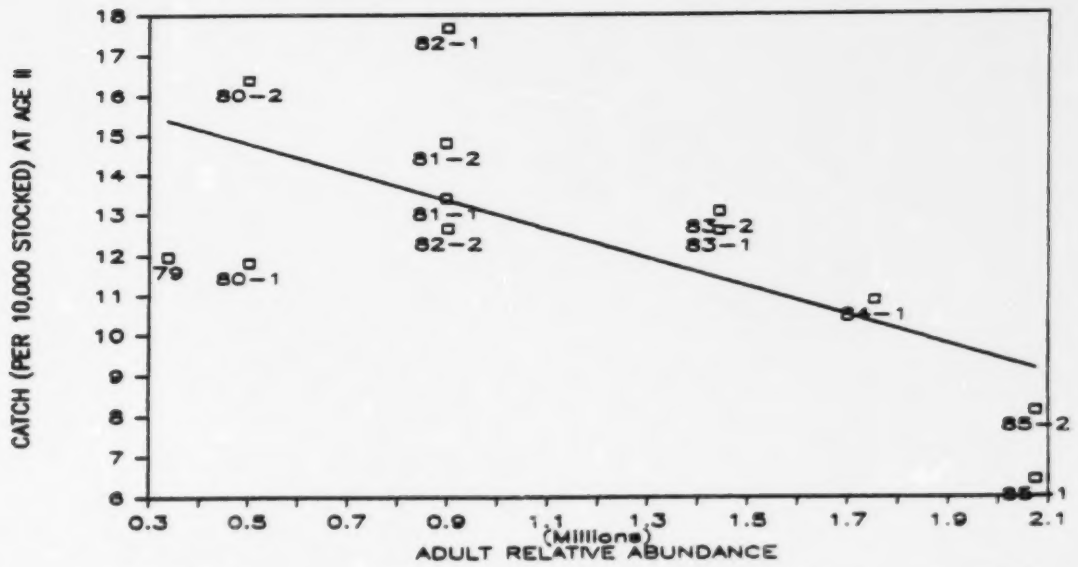

FIGURE 21. Relationship between age 2 trawl catches at Hamlin and adult relative abundance from gill net assessment catches from U.S. waters of Lake Ontario.

SUMMARY

The highlight of lake trout rehabilitation in Lake Ontario in 1987 was meeting the survival guidelines of the Joint Plan. Creel survey CPUE's indicated that 66% of adult (age V and older) lake trout survived between 1986 and 1987, and a similar comparison of gill net abundance between 1985 and 1987 also indicated that survival improved substantially. These trends were confirmed by the improvement in average age of adult females, to 6.3 years, the highest level observed to date, but was still less than the Joint Plan target of 7.5 years. However, average age is expected to lag survival, so more improvement is expected in the future.

The dramatic gain in survival of adults within the last two years was the result of both sea lamprey and fishing mortality reductions. Lake trout angler harvest has remained stable in US waters since 1984 (at approximately 85,000), and is still low but increasing in Canadian waters, while losses from sea lamprey predation have been declining since 1985. At the same time, the abundance of adults increased; hence, rates of mortality for both of these factors diminished. The combination of selectively low sea lamprey mortality in fall 1987 (111,220 carcasses) and the expected reduction in angling harvest in 1988 could lead to further improvements in adult survival and continued expansion in numbers of spawners.

Although the lake trout spawning stock expanded and grew older, survival of young lake trout (age 2) decreased dramatically. Trawl recoveries of age 2 Superior strain lake trout indicated that relative survival in 1987 was reduced nearly 50% from levels measured several years ago. A significant inverse relationship between adult abundance and age 2 catches indicated that predation from large numbers of adult lake trout was one possible cause . However, poorer survival may also be related, somewhat, to recent hatchery stockings which were reared at higher densities. This decline in effective recruitment was not considered in the Joint Plan, nor in any recent rehabilitation modelling, but it could inhibit attainment of a suitable numbers of spawners, while at the same time meeting or exceeding survival and female average age objectives. This density dependent effect on the survival of young as well as changes in growth and maturity, should be examined more closely in the rehabilitation model for Lake Ontario, and should also be reviewed more fully in the updated Joint Plan.

Marking rates (stages A1, A2 and A3) have been the traditional statistic used throughout the Great Lakes to gauge sea lamprey-lake trout interactions. Estimates of carcass density was a new approach that was initiated on Lake Ontario in 1982. However, the two statistics did not agree. A re-examination of the marking and carcass density data from Lake Ontario demonstrated that inclusion of stages A2 and A3 in the marks-of-the-year statistic masked the underlying relation between marking and carcass density. The correlation between A1 marking rates

in September and carcass density in October suggests that A1 marking rates are a good measure of sea lamprey predation.

Studies that were designed to maximize recruitment of young lake trout have led to several new guidelines for stocking. Planting yearling lake trout in May from shore (except in the Eastern Basin) resulted in similar survival rates to other approaches, and increasing the numbers of fish grown per raceway afforded no recruitment advantage. An issue in the near future will be the relationship between rearing density and survival.

Egg traps have potential for use as an assessment tool throughout the Great Lakes. At Stony Island, a site with a known concentration of spawning fish, large numbers of eggs were collected with a minimum of risk and effort. This approach could provide the best description of where lake trout spawn, while also supplying large samples of eggs for genetic research. Trap design could be improved, with consideration for mass production capability. A cheap, readily available plastic egg trap would be of great value, not only to Lake Ontario biologists, but to workers throughout the Great Lakes.

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Great Lakes Fishery Commission
Lake Ontario Committee
March 8-9, 1988

ONTARIO MINISTRY OF NATURAL RESOURCES (OMNR)
and
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION (DEC)
1988 LAKE ONTARIO COMMITTEE REPORT

LAKE ONTARIO SALMONID STOCKING AND MARKING PROGRAM

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INTRODUCTION

The Lake Ontario fish stocking and marking program report is prepared annually to present numbers of fish stocked and identifying marks used on fish stocked into Lake Ontario by OMNR and DEC.1/ Tables 1 and 2 provide statistics on numbers of fish stocked in 1986 and 1987 and numbers of fish proposed for 1988 stocking. Tables 3 and 4 provide information on numbers of fish stocked into Lake Ontario from 1968 through 1987 by both agencies. Tables 5 and 6 provide detailed information about the areas of Lake Ontario that were stocked in 1987. In addition, these tables (5 and 6) include species information including strain, hatchery of origin, size at stocking and marks. Table 7 shows the deviations from the proposed 1987 stocking and explains the reasons for the changes.

The proposed stocking by OMNR and DEC for 1988 is presented as numbers of fish by species, expected age of stocking, and proposed stocking sites in Tables 8 and 9.

RESULTS

The 1987 Lake Ontario fish stocking consisted only of salmon and trout. The total number of salmonids stocked by all agencies combined was 8,224,500. The stocking of 2,661,900 salmonids in Province of Ontario waters was slightly above the number proposed for 1987 stocking. The New York stocking of 5,562,600 was also above the proposed goal. The surplus consisted of fingerling coho salmon stocked by Ontario, chinook salmon stocked by New York, steelhead fingerlings and yearlings stocked by New York, and Atlantic salmon yearlings in US waters and fingerlings in both US and Canadian waters.

1/ All lake trout stocked by DEC were provided by United States Fish and Wildlife Service from the Allegheny National Fish Hatchery. Penobscot strain Atlantic salmon were provided by United States Fish and Wildlife Service from Tunison Laboratory at Cortland National Fish Hatchery.

Important deviations from proposed stocking included DEC stocking 411,000 surplus spring fingerling chinook salmon; both DEC and OMNR stocking surplus (143,000) fingerling lake trout which partially compensated for a shortage of 306,000 yearlings, and a reduction of 347,000 yearling coho salmon. These stocking deviations will probably result in somewhat better chinook fishing in summer of 1989, little effect on the lake trout, and a major deemphasis on lake and river harvest of coho salmon in 1988.

The DEC and OMNR representatives of the Lake Ontario Committee have met concerning stocking limits for Lake Ontario as recommended in the 1987 Lake Ontario Salmonid Marking and Stocking Program report. The initial meeting resulted in an upper limit for all species stocked at 8.2 million salmonids, which is within present stocking limits for both agencies.

TERMINOLOGY

Following are explanations for some of the terms and abbreviations used in the following tables.

Steelhead:	a migratory rainbow trout, technically, one which undergoes the parr-smolt transformation and migrates to Lake Ontario from the stream in which it was planted, or hatched in the case of wild fish.
Domestic Rainbow trout:	a rainbow trout that is not known to exhibit a parr-smolt transformation and, therefore, is planted directly into the lake since it would not be expected to migrate to the lake if planted in a stream.
Mark:	body part removed or tag added for identification:
LV:	Left Ventral fin
Ad-LV:	Adipose and Left Ventral fins
RV:	Right Ventral
Ad-LP:	Adipose and Left Pectoral fins
LV-RV:	Both Ventral fins
RP:	Right Pectoral fin
LP:	Left Pectoral fin
LVLM:	Left Ventral fin and Left Maxillary
CWT:	Coded Wire Tag (60-42-14; the first two numbers are the agency code; i.e. 60 and 63 are the agency codes for DEC; and OMNR respectively, the third through sixth numbers identify individual lots of fish)

Table 1. Salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1986 and 1987 and proposed for 1988.

Species	Age	Number Stocked 1986	Number Stocked 1987	Number Proposed 2/ 1988
Brown Trout	Yearling	282,928	256,362	435,000
	Fingerling	13,989	62,331	0
	Adult 1/	842	210	0
	Total	297,759	318,903	435,000
Coho	Yearling	183,195	187,662	160,000
	Fingerling	89,762	212,593	80,000
	Total	272,957	400,255	240,000
Lake Trout	Yearling	851,876	1,066,152	1,150,000
	Fingerling	0	55,592	0
	Total	851,876	1,121,744	1,150,000
Chinook	Fingerling	597,542	513,931	500,000
Rainbow Trout	Yearling	200,000	306,060	175,000
Atlantic Salmon	Fingerling	0	1,009	50,000
	TOTAL	2,220,134	2,661,902	2,550,000

1/ Adult = 35 to 46 month old broodstock fish

2/ Subject to public consultation during fisheries management planning

TABLE 2. Salmon and trout stocked in New York waters of Lake Ontario in 1986, 1987, and proposed for 1988.

Species	Age	Number Stocked 1986	Number Stocked 1987	Number Proposed 1988
Brown Trout	Yearling	442,300	417,800	500,000
Coho	Yearling	194,000	80,000	350,000
	Fingerling	353,500	0	0
	Total	547,500	80,000	350,000
Lake Trout	Yearling	1,012,200	818,100	1,020,000
	Fingerling	369,900	366,600	180,000
	Total	1,382,100	1,184,700	1,200,000
Chinook	Fingerling	2,849,200	3,111,300	2,700,000
Rainbow Trout				
Washington Steelhead	Yearling	341,000	418,300	330,000
	Fingerling	0	129,400	0
	Total	341,000	547,700	330,000
Domestic	Yearling	79,500	90,600	115,000
	Fingerling	23,000	40,200	23,000
	Total	102,500	130,800	138,000
Skamania	Yearling	66,000	25,000	82,000
Finger Lakes (wild)	Fingerling	55,000	0	0
Atlantic Salmon	Yearling	55,400	58,100	49,000
	Fingerling	0	7,100	0
	II+	0	100	0
	Total	55,400	65,300	49,000
	TOTAL	5,841,000	5,562,600	5,349,000

TABLE 3. Approximate numbers (in 1000's) of salmon and trout planted in Province of Ontario waters of Lake Ontario from 1968 through 1987.

Species	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Coho Y	0	138	148	160	122	272	438	226	166	313	201	156	77	169	112	142	106	191	183	188
Coho F	0	0	0	0	0	0	0	0	0	0	0	130	172	165	0	76	0	0	90	129
Coho f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84
Chinook f	0	0	0	89	190	0	225	0	0	0	393	147	18	12	270	125	662	703	598	514
Lake Trout Y	0	0	0	0	0	0	0	0	194	288	200	201	383	387	391	372	493	729	852	1066
Lake Trout F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56
Brown Trout II+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Brown Trout Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	122	136	283	256
Brown Trout F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	27	14	62
Brown Trout f	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
Rainbow Trout Y	12	10	10	18	107	28	30	7	108	110	114	201	149	81	68	105	110	106	200	306
Rainbow Trout F	0	0	0	0	0	30	94	0	0	0	10	0	0	0	0	0	0	0	0	0
Rainbow Trout f	0	0	0	0	0	0	0	22	0	0	0	0	180	0	0	0	0	0	0	0
Atlantic Salmon F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Splake Y	24	25	0	0	48	39	26	0	6	0	0	0	0	0	0	0	0	0	0	0
Kokanee f	0	20	45	50	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kokanee fry	228	334	1982	678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	264	527	2185	995	528	369	813	255[1/]	474[1/]	711[1/]	918	835	979	821	889	943	1494	1893	2221	2662

Legend: II+: Two year old fish
Y: Yearlings, stocked between January and June usually 5" to 9"
F: Fall fingerlings, stocked between September and December usually 3½" to 6"
f: Spring fingerlings, stocked May and June usually 2½" to 3"

1/ Does not include planting of 15,000 rainbow trout eggs in 1975 or lake trout eggs planted in 1976 (90,000) and 1977 (200,000)

Table 4. Approximate numbers (in 1000's) of salmon and trout planted in New York waters of Lake Ontario from 1968 through 1987.

Species	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Coho Y	25	119	294	122	230	215	147	452	177	40	40	175	0	0	307	396	289	351	194	80
Coho F	15	0	0	0	0	25	69	361	0	0	40	169	299	0	60	51	454	25	268	0
Coho f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0
Chinook f	0	70	140	100	426	691	963	920	593	0	0	222	788	1468	1808	2759	3878	3022	2849	3111
Chinook F	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake Trout Y	0	0	0	0	0	66	128	0	63	0	505	492	1012	1031	1054	1086	1045	984	1012	818
Lake Trout F	0	0	0	0	0	0	517	513	274	298	538	193	182	112	205	11	0	202	370	367
Lake Trout II+	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Brown Trout Y	0	0	0	0	0	60	81	108	157	162	94	219	257	365	503	479	408	440	442	418
Brown Trout F	0	0	0	0	0	0	42	113	153	195	0	0	272	89	153	100	0	0	0	0
Brown Trout f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	132	0	0	0	0
Rainbow Trout Y	0	0	0	0	0	0	19	0	54	50	41	41	85	76	38	108	93	84	80	91
Rainbow Trout F	0	0	0	0	0	0	10	99	106	67	125	167	411	147	96	105	105	105	23	40
Rainbow Trout f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	549	0	0
Steelhead Y	0	0	0	0	0	0	50	0	29	24	147	117	263	260	114	112	293	334	407	443
Steelhead F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	10	55	129
Brook Trout F	0	0	0	0	0	0	0	0	0	0	0	0	326	106	0	0	0	0	0	0
Atlantic Salmon Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	25	55	55	58
Atlantic Salmon F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	7
TOTALS	40	189	434	222	656	1066	2026	2566	1607	823	1530	1795	3895	3656	4441	5528	6590	6174	5840	5562

Legend: II+: Two year old fish
Y: Yearlings, stocked between January and June usually 5" to 9"
F: Fall fingerlings, stocked between September and December usually 3½" to 6"
f: Spring fingerlings, stocked May and June usually 2½" to 3"

Table 5. Detailed information on salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1987.

Species	Location	Hatchery Reared	Strain or Egg Source	Age Months	# Fish/ Pound	Mark	Number Stocked
Coho Salmon	Credit River	Ringwood	Lake Ontario	3	454	None	83,793
	Credit River	Ringwood	Lake Ontario	8	31	Ad-RV	66,337
	Credit River	Ringwood	Lake Ontario	14	19	Ad	48,418
				CREDIT RIVER TOTAL			**198,548**
	Bronte Creek	Ringwood	Lake Ontario	8	32	Ad-RV	23,923
	Bronte Creek	Ringwood	Lake Ontario	14	24	RV	70,809
				BRONTE CREEK TOTAL			**94,732**
	Twelvemile Creek (Port Dalhousie)	Ringwood	Lake Ontario	8	31	Ad-RV	38,540
	Twelvemile Creek (Port Dalhousie)	Ringwood	Lake Ontario	14	25	RV	68,435
				TWELVEMILE CREEK TOTAL			**106,975**
				TOTAL SPRING FINGERLING COHO			**83,793**
				TOTAL FALL FINGERLING COHO			**128,800**
				TOTAL YEARLING COHO			**187,662**
				TOTAL COHO			**400,255**
Atlantic Salmon	Wilmont Creek	Normandale	Landlocked NY (Little Clear)	10	24	RV	1,009
				TOTAL ATLANTIC SALMON			**1,009**

Table 5. Detailed information on salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1987.

Species	Location	Hatchery Reared	Strain or Egg Source	Age Months	# Fish/ Pound	Mark	Number Stocked
Chinook Salmon	Credit River	Ringwood	Lake Ontario	6	104	None	182,706
	Bronte Creek	Ringwood	Lake Ontario	6	108	None	93,451
	Hamilton Harbor	Ringwood	Lake Ontario	6	115	None	46,101
	Oshawa Creek	Ringwood	Lake Ontario	6	100	None	26,000
	Twelvemile Creek (Port Dalhousie)	Ringwood	Lake Ontario	6	120	None	139,297
	Bowmanville Creek	Ringwood	Lake Ontario	6	101	None	26,376
				TOTAL FINGERLING CHINOOK			**513,931**
Rainbow Trout	Credit River	Normandale	Ganaraska	10	24	Ad	75,000
	Credit River	Normandale	Ganaraska	11	41	Ad	29,530
	Credit River	Deer Lake	Ganaraska/ Normandale	11	83	Ad	10,000
	Credit River	Normandale	Ganaraska/ Normandale	12	45	Ad	25,030
				CREDIT RIVER TOTAL			**139,560**
	Bronte Creek	Deer Lake	Ganaraska/ Normandale	11	103	Ad	91,500
	Rouge River	Normandale	Ganaraska	10	22	Ad	30,000
	Duffins Creek	Normandale	Ganaraska	10	29	Ad	10,000
	Duffins Creek	Normandale	Ganaraska	11	87	Ad	35,000
				DUFFINS CREEK TOTAL			**45,000**
				TOTAL RAINBOW TROUT			**306,060**

Table 5. Detailed information on salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1987.

Species	Location	Hatchery Reared	Strain or Egg Source	Age Months	# Fish/ Pound	Mark	Number Stocked
Brown Trout	Burlington	Chatsworth	Ganaraska/ Codrington	17	5	RV	22,774
	Rouge River	Codrington	Ganaraska/ Codrington	9	37	None	8,556
	Rouge River	Codrington	Ganaraska/ Codrington	16	13	RV	25,000
	Rouge River	Chatsworth	Ganaraska/ Codrington	15	11	RV	7,918
				ROUGE RIVER TOTAL			**41,474**
	Ganaraska River	Hardwood	Ganaraska/ Codrington	9	38	Ad-RV	15,000
	Ganaraska River	Codrington	Ganaraska/ Codrington	15	13	RV	5,000
				GANARASKA RIVER TOTAL			**20,000**
	Humber River	Codrington	Ganaraska/ Codrington	15	13	RV	15,000
	Twelvemile Creek (Port Dalhousie)	Chatsworth	Ganaraska/ Codrington	16	6	RV	22,186
	Jordan Harbor	Chatsworth	Ganaraska/ Codrington	15	11	RV	22,964
	Fifty Mile Point	Chatsworth	Ganaraska/ Codrington	17	53	RV	10,671
	Bluffers Park	Codrington	Ganaraska/ Codrington	16	12	RV	20,000
	Oshawa Creek	Codrington	Ganaraska/ Codrington	15	12	RV	15,000

Table 5. Detailed information on salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1987.

Species	Location	Hatchery Reared	Strain or Egg Source	Age Months	# Fish/ Pound	Mark	Number Stocked
Brown Trout	Duffins Creek	Chatsworth	Ganaraska/ Codrington	15	9	RV	20,000
	Millhaven	Codrington	Ganaraska/ Codrington	9	32	Ad-RV	30,000
	Millhaven	Codrington	Ganaraska/ Codrington	15	13	RV	46,085
	Millhaven	Codrington	Ganaraska/ Codrington	16	11	RV	8,764
	Millhaven	Codrington	Ganaraska	35-46	0.4	Ad, RP	210
				MILLHAVEN TOTAL			**85,059**
	Lowville	Codrington	Ganaraska/ Codrington	8	40	None	8,775
	Ashbridges Bay	Codrington	Ganaraska/	16	13	RV	15,000
				TOTAL FINGERLING BROWN TROUT			**62,331**
				TOTAL YEARLING BROWN TROUT			**256,362**
				TOTAL ADULT BROWN TROUT			**210**
				TOTAL BROWN TROUT			**318,903**

Table 5. Detailed information on salmon and trout stocked in Province of Ontario waters of Lake Ontario in 1987.

Species	Location	Hatchery Reared	Strain or Egg Source	Age Months	# Fish/ Pound	Mark	Number Stocked
Lake Trout	Charity - Main Duck Shoals	White Lake	Killala Lake/ Dorion	16	30	RP	429,689
	Scotch Bonnet Shoal	Deer Lake	Killala Lake/ Dorion	16	39	Ad-RP	121,805
	Scotch Bonnet Shoal	White Lake	Killala Lake/ Dorion	15	30	Ad-RP	81,857
				SCOTCH BONNET SHOAL TOTAL			**203,662**
	Fifty Mile Point	North Bay	Lake Manitou	14-15	28	Ad-RV	132,712
	Fifty Mile Point	North Bay	Lake Manitou	15	32	RV	111,558
				FIFTY MILE POINT TOTAL			**244,270**
	Port Hope	Hardwood	Lake Manitou	11	28	Ad-CWT	48,834
	Port Hope	Hardwood	Lake Manitou	11	27	Ad-CWT	11,758
	Port Hope	North Bay	Lake Manitou	15	33	RV	75,031
				PORT HOPE TOTAL			**130,623**
	Cobourg	Deer Lake	Killala Lake/ Dorion	16	46	RV	113,500
				TOTAL FINGERLING LAKE TROUT			**55,592**
				TOTAL YEARLING LAKE TROUT			**1,066,152**
				TOTAL LAKE TROUT			**1,121,744**

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks* Applied	Number Stocked
					Lake Trout Yearlings					
Lake Ont.	Olcott	708	5/19	1986	Allegheny	Superior	18	11.6	60-44-24	41,100
Lake Ont.	Olcott	708	5/19	1986	Allegheny	Seneca	18	11.1	60-44-29	41,100
Lake Ont.	Olcott	708	5/19	1986	Allegheny	Jenny Lake	18	8.6	60-43-59	41,100
						OLCOTT TOTAL				**123,300**
Lake Ont.	Hamlin	713	5/20	1986	Allegheny	Superior	18	10.0	60-44-19	41,100
Lake Ont.	Hamlin	713	5/20	1986	Allegheny	Seneca	18	12.3	60-44-30	40,000
Lake Ont.	Hamlin	713	5/20	1986	Allegheny	Jenny Lake	18	8.2	60-43-58	41,100
Lake Ont.	Hamlin	713	5/27	1986	Allegheny	Superior	18	9.8	60-44-22	41,100
						HAMLIN TOTAL				**163,300**
Lake Ont.	Sodus	818	5/21	1986	Allegheny	Superior	18	11.0	60-44-26	41,000
Lake Ont.	Sodus	818	5/21	1986	Allegheny	Seneca	18	12.0	60-44-27	41,100
Lake Ont.	Sodus	818	5/21	1986	Allegheny	Jenny Lake	18	8.2	60-43-57	41,100
Lake Ont.	Sodus	818	5/28	1986	Allegheny	Superior	18	10.5	60-44-21	41,100
						SODUS TOTAL				**164,300**

*All coded wire tagged lake trout receive an Adipose clip.

Table 6 Page 2

Detailed information on salmon and trout stocked in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks* Applied	Number Stocked
					Lake Trout Yearlings					
Lake Ont.	Selkirk	623	5/22	1986	Allegheny	Superior	18	11.3	60-44-23	41,100
Lake Ont.	Selkirk	623	5/22	1986	Allegheny	Seneca	18	10.0	60-44-28	41,100
Lake Ont.	Selkirk	623	5/22	1986	Allegheny	Jenny Lake	18	8.5	60-43-61	41,100
Lake Ont.	Selkirk	623	5/28	1986	Allegheny	Superior	18	9.5	60-44-15	41,100
						SELKIRK TOTAL				**164,400**
Lake Ont.	Stony	422	5/15	1986	Allegheny	Superior	18	12.2	60-44-18	41,100
Lake Ont.	Stony	422	5/15	1986	Allegheny	Seneca	18	13.0	60-44-31	38,400
Lake Ont.	Stony	422	5/15	1986	Allegheny	Jenny Lake	18	10.0	60-43-60	41,100
						STONY TOTAL				**120,600**
Lake Ont.	Dablon	322	5/29	1986	Allegheny	Superior	18	10.6	60-44-9	41,100
Lake Ont.	Dablon	322	5/29	1986	Allegheny	Superior	18	10.4	60-44-25	41,100
						DABLON TOTAL				**82,200**
					TOTAL YEARLING LAKE TROUT					**818,100**

*All coded wire tagged lake trout receive an Adipose clip.

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks* Applied	Number Stocked
					Lake Trout Fingerlings					
Lake Ont.	Olcott	708	10/20	1987	Allegheny	Seneca	10	38.0	60-44-39	40,500
Lake Ont.	Olcott	708	10/20	1987	Allegheny	Jenny Lake	10	27.0	60-44-32	40,600
					OLCOTT TOTAL					**81,100**
Lake Ont.	Hamlin	713	10/21	1987	Allegheny	Seneca	10	33.0	60-44-40	40,500
Lake Ont.	Hamlin	713	10/21	1987	Allegheny	Jenny Lake	10	24.0	60-44-33	41,000
					HAMLIN TOTAL					**81,500**
Lake Ont.	Sodus	818	10/22	1987	Allegheny	Seneca	10	33.0	60-44-54	40,500
Lake Ont.	Sodus	818	10/22	1987	Allegheny	Jenny Lake	10	31.0	60-44-36	41,000
					SODUS TOTAL					**81,500**
Lake Ont.	Selkirk	623	10/23	1987	Allegheny	Seneca	10	32.0	60-44-55	40,500
Lake Ont.	Selkirk	623	10/23	1987	Allegheny	Jenny Lake	10	27.0	60-44-37	41,000
					SELKIRK TOTAL					**81,500**
Lake Ont.	Stony	422	10/23	1987	Allegheny	Jenny Lake	10	27.0	60-44-38	41,000
					TOTAL FINGERLING LAKE TROUT					**366,600**
					TOTAL LAKE TROUT					**1,184,700**

*All coded wire tagged lake trout receive an Adipose clip.

Table 6 Page 4

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
Atlantic Salmon Yearlings										
Lindsey Creek	NY Rt. 3 to Co. Rt. 87	0.48	4/15	1986	Adirondack	Little Clear	13½	12.9	LV	11,000
Little Sandy Ck.	Entire	0.50	4/15	1986	Adirondack	Little Clear	13½	12.9	LV	20,000
Little Sandy Ck.	Entire	0.50	4/9	1986	Cortland	Penobscot	14	21.4	Ad-LV	8,010
						LITTLE SANDY CREEK TOTAL				**28,010**
Lake Ont.	East of Oswego Breakwall	721	4/9	1986	Cortland	Penobscot	14	1.6	Ad-LV	1,120
Ironde-quoit Ck.	Entire	0.108	4/23	1986	Adirondack	Little Clear	14	12.0	LV	18,000
						TOTAL YEARLING LITTLE CLEAR				**49,000**
						TOTAL YEARLING PENOBSCOT				**9,130**
						TOTAL YEARLING ATLANTIC SALMON				**58,130**

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
Atlantic Salmon Fingerlings										
Little Sandy Ck.	lower 2 miles	0.50	11/12	1987	Cortland	Penobscot	11	45.9	Ad-LV	7,140
						TOTAL ATLANTIC SALMON FINGERLINGS				7,140
Atlantic Salmon II										
Lake Ont.	Oswego	721	4/8	1986	Cortland	Penobscot	24	1.0	LP	59
						TOTAL ATLANTIC SALMON ADULTS				59
						TOTAL ATLANTIC SALMON				65,329

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Brown Trout Yearlings					
Lake Ont.	Henderson	423	4/29	1986	Salmon R.	Rome	17½	4.7	None	24,900
Lake Ont.	Ray's Bay	523	5/4	1986	Salmon R.	Rome	17½	4.7	None	31,540
Lake Ont.	Selkirk	623	5/27	1986	Salmon R.	Rome	18	4.3	None	4,900
Lake Ont.	Selkirk	623	4/28	1986	Salmon R.	Rome	17½	4.6	None	29,050
						SELKIRK TOTAL				**33,950**
Lake Ont.	Oswego	721	5/7	1986	Salmon R.	Rome	17½	5.0	None	31,540
Lake Ont.	Fair Haven State Park	720	4/20	1986	Caledonia	Rome	15½	7.5	None	29,100
Lake Ont.	Sodus Point	819	5/5	1986	Caledonia	Rome	16	5.2	None	7,450
Lake Ont.	Sodus Point	819	4/13	1986	Caledonia	Rome	15½	5.3	None	20,750
						SODUS POINT TOTAL				**28,200**
Lake Ont.	Pultneyville	817	5/8	1986	Caledonia	Rome	16½	5.2	None	7,950
Lake Ont.	Pultneyville	817	5/6	1986	Caledonia	Rome	16	5.1	None	10,380
						PULTNEYVILLE TOTAL				**18,330**

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Brown Trout Yearlings					
Lake Ont.	Webster	816	4/22	1986	Caledonia	Rome	15½	5.6	None	20,800
Lake Ont.	Irondequoit	815	4/23	1986	Caledonia	Rome	15½	5.3	None	20,800
Lake Ont.	Rochester	815	5/7	1986	Caledonia	Rome	16	5.2	None	16,650
Lake Ont.	Rochester	815	5/5	1986	Caledonia	Rome	16	4.7	None	9,950
						ROCHESTER TOTAL				**26,600**
Lake Ont.	Braddock's Bay	815	5/11	1986	Caledonia	Rome	16½	3.3	None	13,900
Lake Ont.	Braddock's Bay	815	5/12	1986	Caledonia	Rome	16½	3.0	None	6,900
						BRADDOCK'S BAY TOTAL				**20,800**
Lake Ont.	Hamlin Beach State Park	713	3/9	1986	Caledonia	Rome	14½	4.6	None	22,700
Lake Ont.	Hamlin Beach State Park	713	4/24	1986	Caledonia	Rome	16	5.6	None	8,900
						HAMLIN BEACH ST. PK. TOTAL				**31,600**
Lake Ont.	Point Breeze	711	4/27	1986	Caledonia	Rome	16	4.7	None	16,600
Lake Ont.	Point Breeze	711	5/1	1986	Caledonia	Rome	16	5.0	None	16,600
						POINT BREEZE TOTAL				**33,200**

Table 6 Page 8

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Brown Trout Yearlings					
Lake Ont.	Olcott	708	4/29	1986	Caledonia	Rome	16	5.5	None	16,600
Lake Ont.	Olcott	708	4/30	1986	Caledonia	Rome	16	4.8	None	16,600
						OLCOTT TOTAL				**33,200**
Lake Ont.	Wilson	708	4/27	1986	Caledonia	Rome	16	4.9	None	16,600
Lake Ont.	Wilson	708	4/28	1986	Caledonia	Rome	16	4.0	None	16,600
						WILSON TOTAL				**33,200**
						TOTAL YEARLING BROWN TROUT				**417,760**
						TOTAL BROWN TROUT				**417,760**

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Coho Salmon Yearlings					
Beaverdam Brook	Salmon River Hatchery	0.53-8	4/30	1986	Salmon R.	Salmon R.	15	13.6	None	60,000
Beaverdam Brook	Salmon River Hatchery	0.53-8	5/6	1986	Salmon R.	Salmon R.	15½	11.6	None	20,000
						TOTAL YEARLING COHO SALMON				**80,000**
						TOTAL COHO SALMON				**80,000**

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Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Steelhead Trout Yearlings					
Black River	Dexter Boat Launch	0.19	5/8	1986	Salmon R.	Washington-Salmon River	12	19.0	None	22,000
Stony Ck.	At NY Rt. 3	0.40	5/8	1986	Salmon R.	Washington-Salmon River	12	19.0	None	19,800
South Sandy Ck.	At NY Rt. 3	0.45	4/10	1986	Caledonia	Washington-Salmon River	12	10.4	None	25,000
Beaverdam Brook	At Salmon River Hatchery	0.53-8	4/30	1986	Salmon R.	Washington-Salmon River	11	13.4	LV	51,000
Beaverdam Brook	At Salmon River Hatchery	0.53-8	4/30	1986	Caledonia	Washington-Salmon River	13	7.5	LV	36,000
Beaverdam Brook	At Salmon River Hatchery	0.53-8	5/6	1986	Salmon R.	Washington-Salmon River	12	16.4	None	22,000[1/]
Beaverdam Brook	At Salmon River Hatchery	0.53-8	5/13	1986	Salmon R.	Washington-Salmon River	12	22.0	None	18,600[1/]
						BEAVERDAM BROOK TOTAL				**127,600**

1/ Surplus yearlings

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Steelhead Trout Yearlings					
Orwell Brook	Lower 3 bridges	0.53-6	4/28	1986	Salmon R.	Washington-Salmon River	11	19.0	None	11,000
Spring Bk. Reservoir	Reservoir	0.53-2-P6	4/28	1986	Salmon R.	Washington-Salmon River	11	19.0	None	11,000
Salmon River	Pineville Bridge	0.53	4/24	1986	Salmon R.	Washington-Salmon River	11	19.0	Ad-LV	5,500
Salmon River	Co. Rt. 2A bridge	0.53	4/24	1986	Salmon R.	Washington-Salmon River	11	19.0	Ad-LV	5,500
						SALMON RIVER SYSTEM TOTAL				**160,600**
Catfish Creek	Co. Rt. 1	0.60	4/29	1986	Caledonia	Skamania	12	9.3	Ad-LP	10,000
Oswego River	Oswego Harbor	0.66	5/13	1986	Caledonia	Washington-Salmon River	14	6.3	LV	18,440
Oswego River	Oswego Harbor	0.66	5/19	1986	Caledonia	Skamania	13	9.3	Ad-LP	15,000
						OSWEGO RIVER TOTAL				**33,440**

Table 6 Page 12

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
Steelhead Trout Yearlings										
Ironde-quoit Ck.	Canal to T-30	0.108	5/13	1986	Salmon R.	Washington-Salmon River	12	19.0	None	26,400
Genesee River	Old Naval Militia	0.117	4/2	1986	Caledonia	Washington-Salmon River	12	9.0	None	20,000
Salmon Creek	lower portion	0.125	4/15	1986	Caledonia	Washington-Salmon River	13	8.0	None	10,000
Sandy Creek	below Rt. 18	0.130	4/15	1986	Caledonia	Washington-Salmon River	13	8.0	None	13,300
Oak Orchard Ck.	Twin Bridges	0.138	4/8	1986	Caledonia	Washington-Salmon River	12	6.0	None	20,000
Keg Creek	Rt. 18 Bridge	0.148	5/13	1986	Salmon R.	Washington-Salmon River	12	22.0	None	12,200
E. Branch Twelvemile Creek	Rt. 18 Crossing	0.152	4/9	1986	Caledonia	Washington-Salmon River	13	9.0	None	13,300
Twelvemile Creek	Rt. 18 & Youngstown Rd. Crossings	0.152A	4/9	1986	Caledonia	Washington-Salmon River	13	9.0	None	13,300
Niagara River	Lewiston	0.158	4/2	1986	Caledonia	Washington-Salmon River	12	9.0	None	25,000

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
Steelhead Trout Yearlings										
Niagara River	Lewiston	0.158	5/13	1986	Salmon R.	Washington-Salmon River	12	22.0	None	19,000
						TOTAL NIAGARA RIVER				**44,000**
						TOTAL SKAMANIA STEELHEAD				**25,000**
						TOTAL WASHINGTON STEELHEAD				**418,340**
						TOTAL YEARLING STEELHEAD				**443,340**
Steelhead Trout Fingerlings										
Grindstone Creek	Fernwood and downstream	0.54	10/28	1987	Bath	Finger Lakes Wild	4	150	None	69,350 2/
Oswego River	Oswego Harbor	0.66	9/28	1987	Caledonia	Washington-Salmon River	5	37	None	30,000 2/
Genesee River	Old Naval Militia	0.117	10/5	1987	Caledonia	Washington-Salmon River	5	40	None	30,000 2/
						TOTAL STEELHEAD FINGERLINGS				**129,350**
						TOTAL STEELHEAD				**572,690**

2/ Surplus Fingerlings

Table 6 Page 14

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
				Rainbow Trout Yearlings						
Lake Ont.	Association Island	423	4/23	1986	Salmon R.	Nashua	12	3.8	None	20,000
Lake Ont.	Selkirk Shores State Park	623	4/23	1986	Salmon R.	Nashua	12	4.0	None	20,000
Lake Ont.	Sodus Point	819	5/13-14	1986	Caledonia	Nashua	13	3.5	None	14,400
Lake Ont.	Hamlin Beach State Park	713	4/28	1986	Caledonia	Nashua	12	3.8	None	16,000
Lake Ont.	Olcott Harbor	708	4/17	1986	Caledonia	Nashua	12	4.0	None	7,700
Lake Ont.	Wilson Harbor	707	4/17	1986	Caledonia	Nashua	12	4.0	None	12,500
						TOTAL RAINBOW TROUT YEARLINGS				**90,600**
				Rainbow Trout Fingerlings						
Lake Ont.	Fair Haven State Park	720	9/22, 24	1987	Allegheny	Wytheville	10	8.0	None	17,200 1/
Lake Ont.	Hamlin Beach State Park	713	9/25	1987	Caledonia	Western Fisheries Center	5	19.5	None	23,000

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Chinook Salmon Fingerlings					
Black River	Dexter boat launch	0.19	5/12	1987	Salmon R.	Salmon R.	4	100	None	200,000
N. Sandy Creek	below NY Rt. 3	0.44	5/12	1987	Salmon R.	Salmon R.	4	105	None	100,000
S. Sandy Creek	below NY Rt. 3	0.45	5/12	1987	Salmon R.	Salmon R.	4	105	None	100,000
Salmon River	Beaverdam Brook	0.53-8	5/31	1987	Salmon R.	Salmon R.	5	78	None	395,000
Salmon River	NY Rt. 3	0.53	5/4	1987	Salmon R.	Salmon R.	4	119	None	58,250
Salmon River	NY Rt. 3	0.53	5/8	1987	Salmon R.	Salmon R.	4	101	None	141,750
Salmon River	NY Rt. 3	0.53	5/14	1987	Salmon R.	Salmon R.	4	100	None	100,000
						SALMON RIVER TOTAL				**695,000**
Oswego River	Oswego Harbor	0.66	5/12	1987	Salmon R.	Salmon R.	4	94	None	250,000
Little Sodus Bay	Fair Haven State Park	0.74	5/20, 21,28	1987	Salmon R.	Salmon R.	5	92	None	200,000
Sodus Bay	near outlet	0.84	5/28	1987	Salmon R.	Salmon R.	5	94	None	200,000

Table 6 Page 16

Detailed information on salmon and trout stocked
in New York Lake Ontario waters in 1987

Area Stocked	Location	Grid/ Key	Date Stocked	Year Class	Hatchery Reared	Strain or Egg Source	Age in Months	# Fish/ Pound	Marks Applied	Number Stocked
					Chinook Salmon Fingerlings					
Genesee River	Old Naval Militia	0.117	5/8	1987	Caledonia	Salmon R.	4	103	None	316,330
Sandy Creek	below Rt. 19 bridge	0.130	5/28, 29	1987	Salmon R.	Salmon R.	5	90	None	180,000
Oak Orchard Ck.	Twin Bridges	0.138	5/6,7	1987	Caledonia	Salmon R.	4	96	None	300,000
Eighteen Mile Creek	Olcott Harbor	0.148	5/26	1987	Salmon R.	Salmon R.	5	88	None	200,000
Twelvemile Creek	Wilson Harbor	0.152	5/29	1987	Salmon R.	Salmon R.	5	85	None	120,000
Niagara River	Lewiston	0.158	5/20	1987	Salmon R.	Salmon R.	5	92	None	250,000
						TOTAL FINGERLING CHINOOK SALMON				**3,111,330**

Table 7. Important deviations from the proposed stocking numbers by OMNR and DEC in 1987.

Species	Agency	Number (in thousands)	Reason
Chinook	DEC	+411f	Better survival in hatchery than anticipated
Lake trout	DEC	+187F -202Y	Adjustments planned in the stocking proposal
	OMNR	+56F -104Y	Shortfall of yearlings. Better than anticipated growth and lower water levels reduced hatchery yearling capacity.
Coho	DEC	-270Y	Temporary reduction in inventory due to vacancies in hatcheries.
	OMNR	-77Y +129F	Due to experimental stocking of fall fingerlings rather than spring yearlings.
		+84f	Surplus of fingerlings due to excellent early survival.
Steelhead	DEC	+31Y +129F	Hatchery surpluses.
Rainbow trout	DEC	-24Y	Shortfall of yearlings
Brown trout	DEC	-82Y	Statewide shortage of brown trout
	OMNR	+62F	Extra production

Legend: Y: Yearlings, stocked between January and June, usually 5" to 9"
F: Fall fingerlings, stocked between September and December usually 3½" to 6"
f: Spring fingerlings, stocked May and June usually 2½" to 3"

Table 8. Proposed 1988 stocking in Province of Ontario waters of Lake Ontario

Species	Location 1/	Quantity 2/	Age
Coho salmon	Credit River	100,000	Yearling
	Bronte Creek	30,000	Yearling
	Martindale Pond	30,000	Yearling
	Credit River	50,000	Fall Fingerling
	Bronte Creek	10,000	Fall Fingerling
	Martindale Pond	20,000	Fall Fingerling
Chinook salmon	Credit River	168,000	Spring Fingerling
	Hamilton Harbor	63,000	Spring Fingerling
	Bronte Creek	63,000	Spring Fingerling
	Niagara Area	126,000	Spring Fingerling
	Cobourg Area	25,000	Spring Fingerling
	Oshawa Creek	20,000	Spring Fingerling
	Bowmanville Creek	20,000	Spring Fingerling
	Brighton Area	15,000	Spring Fingerling
Brown trout	12 Mile Creek	35,000	Yearling
	Jordan Harbor	35,000	Yearling
	Collins Bay	55,000	Yearling
	Parrott's Bay	55,000	Yearling
	Bronte Creek	35,000	Yearling
	50 Mile Point	35,000	Yearling
	Ganaraska River	15,000	Yearling
	Oshawa Creek	25,000	Yearling
	Cobourg Area	10,000	Yearling
	Humber River	35,000	Yearling
	Rouge River	25,000	Yearling
	Duffins Creek	25,000	Yearling
	Toronto Island	25,000	Yearling
	Bluffers Park	25,000	Yearling
Lake trout	50 Mile Point	200,000	Yearling
	Port Hope	200,000	Yearling
	Scotch Bonnet Shoal	250,000	Yearling
	Charity-Main Duck Sh.	500,000	Yearling
Rainbow trout	Credit River	100,000	Yearling
	Bronte Creek	75,000	Yearling
Atlantic salmon	Credit River	40,000	Yearling
	Wilmot Creek	10,000	Yearling

1/ Subject to public consultation during fisheries management planning

Table 9. Proposed 1988 stocking of New York waters in Lake Ontario

REGION	LOCATION	KEY	NUMBER	AGE
		CHINOOK SALMON		
6	Black River	0.19	180,000	4 months
6	North Sandy Creek	0.45	90,000	4 months
6	South Sandy Creek	0.45	90,000	4 months
7	Salmon River	0.53	300,000	4 months
7	Lower Salmon River	0.53	270,000	4 months
7	Oswego River	0.66	225,000	4 months
7	Little Sodus Bay	0.73	180,000	4 months
8	Sodus Bay	0.84	180,000	4 months
8	Genesee River	0.117	270,000	4 months
8	Sandy Creek	0.130	180,000	4 months
8	Oak Orchard Creek	0.138	270,000	4 months
9	Eighteenmile Creek	0.148	180,000	4 months
9	Twelvemile Creek	0.152	60,000	4 months
9	Lower Niagara River	0.157	225,000	4 months
		TOTAL	2,700,000	
		COHO SALMON		
6	Black River	0.19	30,000	Yearling
6	North Sandy Creek	0.45	15,000	Yearling
6	S. Sandy Creek	0.45	15,000	Yearling
7	Salmon River	0.53	90,000	Yearling
7	Oswego River	0.66	30,000	Yearling
8	Sodus Creek	0.84	30,000	Yearling
8	Genesee River	0.117	25,000	Yearling
8	Sandy Creek	0.130	30,000	Yearling
8	Oak Orchard Creek	0.138	30,000	Yearling
9	Eighteenmile Creek	0.148	30,000	Yearling
9	Niagara River	0.157	25,000	Yearling
		TOTAL	350,000	
		ATLANTIC SALMON		
6	Lindsey Creek	0.48	11,000	Yearling
7	Little Sandy Creek	0.50	20,000	Yearling
8	Irondequoit Creek	0.108	18,000	Yearling
		TOTAL	49,000	

Table 9. Proposed 1988 stocking of New York waters in Lake Ontario

REGION	LOCATION	KEY	NUMBER	AGE
		BROWN TROUT		
6	Ray Bay	523	38,000	Yearling
6	Henderson Bay	424	30,000	Yearling
7	Fairhaven Beach St. Pk.	720	35,000	Yearling
7	Oswego Harbor	721	38,000	Yearling
7	Selkirk Shores St. Pk.	623	35,000	Yearling
8	Hamlin Beach St. Pk.	713	38,000	Yearling
8	Irondequoit	815	25,000	Yearling
8	Genesee River	815	32,000	Yearling
8	Braddocks	815	25,000	Yearling
8	Webster	816	25,000	Yearling
8	Point Breeze	711	40,000	Yearling
8	Sodus	819	34,000	Yearling
8	Pultneyville	817	25,000	Yearling
9	Wilson	707	40,000	Yearling
9	Olcott	708	40,000	Yearling
		TOTAL	500,000	
		LAKE TROUT		
6	Dablon Point	322-323	120,000	Yearling
6	Dablon Point	322-323	50,000	Yearling
6	Stony Point	422-423	120,000	Yearling
6	Stony Point	422-423	50,000	Yearling
6	Stony Point	422-423	60,000	Fingerling
7	Selkirk	623	120,000	Yearling
7	Selkirk	623	50,000	Yearling
7	Selkirk	623	30,000	Fingerling
8	Hamlin Beach	713	120,000	Yearling
8	Hamlin Beach	713	50,000	Yearling
8	Hamlin Beach	713	30,000	Fingerling
8	Sodus	819	120,000	Yearling
8	Sodus	819	50,000	Yearling
8	Sodus	819	30,000	Fingerling
9	Niagara	806	120,000	Yearling
9	Niagara	806	50,000	Yearling
9	Niagara	806	30,000	Fingerling
		TOTAL	1,020,000	Yearling
			180,000	Fingerling

Table 9. Proposed 1988 stocking of New York waters in Lake Ontario

REGION	LOCATION	KEY	NUMBER	AGE
		WASHINGTON STEELHEAD		
6	Black River	0.19	20,000	Yearling
6	South Sandy Creek	0.45	25,000	Yearling
7	Salmon River	0.53	120,000	Yearling
7	Oswego River	0.66	15,000	Yearling
8	Genesee River	0.117	20,000	Yearling
8	Irondequoit Creek	0.108	24,000	Yearling
8	Salmon Creek	0.125	10,000	Yearling
8	Sandy Creek	0.130	13,300	Yearling
8	Oak Orchard Creek	0.138	20,000	Yearling
9	Keg Creek	0.146	11,100	Yearling
9	E. Br. Twelvemile Ck.	0.152	13,300	Yearling
9	Twelvemile Creek	0.152A	13,300	Yearling
9	Lower Niagara River	0.157	25,000	Yearling
		TOTAL	330,000	
		SKAMANIA STEELHEAD		
6	Stony Creek	0.40	18,000	Yearling
7	Catfish Creek	0.60	10,000	Yearling
7	Oswego River	0.66	18,000	Yearling
8	Maxwell creek	0.85	18,000	Yearling
9	Niagara River	0.157	18,000	Yearling
		TOTAL	82,000	
		DOMESTIC RAINBOW TROUT		
6	Henderson Bay	424	25,000	Yearling
7	Selkirk Shores St. Pk.	623	25,000	Yearling
8	Hamlin Beach St. Pk.	713	20,000	Yearling
8	Hamlin Beach St. Pk.	713	23,000	Fingerling
8	Sodus	819	20,000	Yearling
9	Wilson	707	12,500	Yearling
9	Olcott	708	12,500	Yearling
		TOTAL	115,000	Yearling
			23,000	Fingerling

Great Lakes Fishery Commission
Lake Ontario Committee
Gananoque, Ontario
March 8-9, 1988

LAKE ONTARIO SEA LAMPREY ASSESSMENT

by

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ABSTRACT

Indices of parasitic phase sea lampreys in Lake Ontario fell in 1986 as an apparent response to initial lampricide treatments in the Oneida Lake system. This was accompanied by a substantial improvement in lake trout survival, the ultimate justification for the Oneida Lake treatments. Wounding on salmonids did not decrease between 1986 and 1987 as would be expected with the still-expanding salmonid population and assuming a stable sea lamprey population. Evidence of newly transformed sea lampreys from a spring fishing derby indicated an increase between 1986 and 1987, but similar evidence from a season-long boat fishing survey indicated no change in the same period. Evidence from spawning-phase sea lampreys has, in general, been unclear in recent years and has not suggested a continuing decline in the sea lamprey population. Nest counts and trappings of adults in New York streams have shown no trends in recent years. Catches of adults in Canadian streams increased in 1987. A persistent high incidence of males in spawning phase Lake Ontario sea lampreys was further extended in 1987, suggesting either that they react differently to control efforts from upper Great Lakes sea lampreys, or a substantial proportion of recruitment is from untreated sources. While some of this evidence suggests an increase in parasitic phase Lake Ontario sea lampreys from 1986 to 1987, this would not be consistent with the continuation of improved lake trout survival that was measured in 1987. Some of the probable significant sources of 1987 sea lamprey recruitment were treated in 1987 or are scheduled for treatment in 1988, so the outlook for further attrition of the Lake Ontario sea lamprey population is good.

RECOMMENDATIONS

1. Lampricide treatments in the Oneida Lake system, newly discovered streams in southwestern Lake Ontario and remaining Lake Ontario streams should be expedited in a timely manner in order to maintain the improved lamprey/salmonid balance now being experienced.

2. Sea lamprey survey effort should be sufficient to correctly schedule lampricide retreatments and to detect new infestations that can be expected to arise in response to water quality improvement in tributaries.

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1 New York State Department of Environmental Conservation, Cape Vincent, (NYS DEC)
2 Ontario Ministry of Natural Resources, Picton, Ontario (OMNR)
3 United States Fish and Wildlife Service, Oswego, NY (FWS)
4 United States Fish and Wildlife Service, Marquette, MI (FWS)
5 Canada Department of Fisheries and Oceans, Sault Ste. Marie, Ontario (DFO)

3. Untreated sea lamprey infestations in Niagara River and upper Seneca River tributaries should be definitively evaluated and appropriate sea lamprey control measures applied.

INTRODUCTION

This represents a continuing joint effort by the agencies working on Lake Ontario to bring all adult sea lamprey monitoring results together in a single report. Emphasis is on trend-through-time series of biologically stratified and standardized sampling programs.

The most noteworthy action in Lake Ontario sea lamprey control in recent years was experimental extension of the Great Lakes Fishery Commission's (GLFC) lampricide program to the Oneida Lake system in 1984. This action had been recommended on the basis of persistent, unacceptable sea lamprey indices and, more importantly, lake trout mortality. Much joint agency effort since then has been focused on evaluating that action.

Lake Ontario samples failed to detect any favorable changes in 1985 when they first should have occurred. In 1986, however, indices of parasitic phase sea lamprey abundance reflected a decline to the lowest levels yet experienced, and this was accompanied by a substantial improvement in lake trout survival (Schneider, et al 1987). Based on the collective evidence, GLFC approved a second round of lampricide treatments for the Oneida Lake system and this is scheduled for implementation in 1988.

The analysis of 1986 data (Jolliff et al 1987) had posed large natural fluctuations in recruitment from Oneida Lake (Forney 1986) and other uncontrolled potential souces of sea lamprey recruitment as explanations for failure of 1985 Lake Ontario samples to exhibit benefits from the 1984 Oneida Lake lampricide treatments. On this basis it suggested that interventions of this kind should be evaluated over a several-year period in order to accommodate these confounding effects.

METHODS

Previous reports have fully described the methods employed for obtaining the data reported herein, and headings of the data tabulations generally describe how the data were obtained. Only brief descriptions are provided below.

I. Wounding

The terms "wound" and "wounding" as used in this report may refer to any type or stage of lamprey-inflicted lesion when used in a non-specific sense. Where specificity is intended, terminology used is in accordance with King and Edsall (1979). Wounding statistics are taken from all available salmonid species samples which provide stratification of age or size, life history, method and time of capture. Age designations in Roman numerals utilize the convention of assigning a year of age to each winter mark on the fish's scales, which also corresponds to year class.

Incidence of wounding on salmonids is influenced by salmonid abundance, sea lamprey abundance and salmonid mortality. The conceptual relationship may be expressed as:

$$\text{Observed Wounding} = \frac{(\text{Lampreys} \times \text{Attack Frequency} \times \text{Time})}{\text{Salmonids}}$$

minus wounding on salmonids killed.

II. Parasitic-Phase Sea Lampreys

Parasitic phase sea lampreys have been collected via voluntary contributions from sport fishermen participating in the Empire State Lake Ontario (ESLO) Derby. This four-day event conducted along the entire New York shoreline each spring has annually had more than 10,000 salmonids entered. Derby organizers agreed to distribute a GLFC one-page request to solicit voluntary angler donations of lamprey specimens at the check stations.

III. Spawning-Phase Sea Lamprey Indices

The following procedures to assess abundance of spawning-phase sea lamprey have been described in a number of Lake Ontario Committee reports.

A. Lamprey Nest Counts have been documented in standardized sections of New York tributaries since 1971.

B. Assessment Traps and Mechanical Weirs have been operated in recent years by DFO and FWS on a number of Ontario and New York tributaries including some on which nest counts are also conducted.

C. Length, Weight and Sex Ratio of spawning phase sea lampreys collected in the above efforts, as well as from chemical treatments, are routinely recorded. These features have been shown to reflect stress induced by the chemical control program targeted at upper Great Lakes sea lamprey populations.

RESULTS

I. Wounding

Tables 1 through 7 depict most of the available wounding data from stratified Lake Ontario salmonid samples. Tables 1 through 3 predate the initial lampricide program of 1971 - 72 and clearly reflect the dramatic decline in wounding which followed immediately after the treatments, roughly 1973-74. A steady further decline continued to about 1977 and beyond which is attributed to salmonid increase due to stockng and improved survival rather than continued decline of sea lampreys. It may be noted that non-lake trout salmonid samples, when narrowly stratified, accurately detected trends in wounding as long as the wounding rates on them were sufficiently above zero, and in general strengthen trends indicated by lake trout. This point is illustrated in the data sets of 1981 and 1982, where nearly all samples reflected a decline to very low levels in 1981 (which at the time was attributed to the initial 1980 lampricide treatment of Black River) followed by a fairly sharp and inexplicable resurgence in 1982, which was similarly reflected in nearly all samples.

Of immediate interest is wounding in 1987 and whether it continues the trend of low values observed from 1986 samples. Of the non-lake trout samples, spring age II brown trout and adult Salmon River coho wounding increased somewhat, that on Salmon River age I+ chinook decreased while spring age II coho wounding was unchanged from 1986 (Tables 1-3). Age II+ steelhead from Salmon River have yielded very small sample sizes in recent years and are,

therefore, not very useful. Overall, these samples may suggest a slight increase in 1987 over 1986 wounding, but their low wounding rates probably render them less accurate in detecting moderate changes than they formerly were.

This is the last year that spring age II brown trout and coho salmon wounding (Table 3) will be reported because monitoring of the Spring ESLO Derby will be discontinued and spring nearshore netting by DEC and Niagara coho sampling by OMNR were discontinued several years ago.

Adult steelhead from Ganaraska River are normally sampled by OMNR every odd-numbered year and wounding presented accordingly in this report. However, planned sampling for 1987 was not done and the usual data are not available.

Moving on to wounding on lake trout (Tables 4-7), it may be noted that values on the smaller size groups (12-15.9" FL, 16-19.9" FL and 17 - 20.9" TL) have approached zero in recent years and, therefore, these samples have similarly become less sensitive to moderate changes. For the other size groups in the U.S. September samples (Table 4), it can be seen that more 1987 data points show an increase than show a decrease from 1986, but in general there is no convincing change.

Data in Tables 5, 6 and 7 will be discussed together since they use a similar gill netting method and are from the same Canadian sector of Lake Ontario. A parameter employed in those tables is the wound index, which integrates lake trout CUE with wounding rate. However, of the CUE's obtained for the five 20-23.9" FL and larger groups, three show a decrease from 1986 to 1987. Since lake trout stocking records (Daniels and LeTendre 1987) and survival rates (Schneider et al 1987) indicate that there should have been a population increase, it is apparent that some of the CUE's in Tables 5, 6 and 7 incorrectly reflected abundance. Therefore, the basic wounding rates will be used for this discussion rather than wound index. Considering only 20" FL and larger fish, incidence of stage I wounds decreased between 1986 and 1987 on four out of the five groups. Conversely, incidence of Stage II-IV lesions increased in four of the five groups at the same time. Since Stage II-IV lesions hypothetically include attacks from past parasitic phase sea lamprey cohorts as well as the current one, their incidence is not a direct index to current activity with long-lived fish such as lake trout. Thus, implications from Tables 5, 6 and 7 are unclear.

II Parasitic Phase Sea Lampreys

Table 8 contains results of soliciting parasitic phase sea lampreys from the 4-day spring ELSO Derby on Lake Ontario. The specimens have consistently been virtually all newly transformed animals and hence represent a direct annual index of abundance. In 1987 there was an increase of 34 percent (65 to 87) in the number of sea lampreys turned in compared with 1986, but due to a substantial decrease in the number of salmonids entered in the Derby, the number of lampreys per 1,000 Derby fish (similar to a CUE) increased a dramatic 168 percent (5.7 to 15.3). The large reduction in Derby fish entries is apparently due to the expanding shift in sport fishing effort in New York waters from nearshore (primarily brown trout) to offshore (chinook salmon) with a corresponding shift in landings from many fish to fewer, but considerably larger fish. While this may tend to erode some of the assumptions implicit in such a scheme, the data nevertheless suggest an increase from 1986 to 1987.

In addition to this sampling, the DEC Fishing Boat Census develops estimates of sea lamprey sightings in the April to October boat fishery, which yielded estimates expanded from interviews of 3,309 in 1986 compared with 3,515 in 1987 (NYDEC 1987). Since this increase is similar to the 10.5 percent estimated increase in fishing boat trips and 7.2 percent estimated increase in salmonids harvested, it does not corroborate the 1987 increase indicated by sea lampreys turned in to the spring ESLO Derby.

The sample number of 1987 sea lamprey sightings from which the Fishing Boat Census estimate was expanded was 99, compared with 87 turned into the ESLO Derby. (C.P. Schneider, personal communication 1/).

III. Spawning-Phase Sea Lamprey Indices

Given the life history of sea lampreys, 1986 was the first year in which spawning-phase indices would be expected to have reflected effects of the 1984 Oneida Lake lampricide treatments. However, wounding and other evidence suggested that there was no effect from those treatments in 1985 when they were first expected to be reflected in the parasitic phase. By 1986, wounding and other indices did reflect a decline in the parasitic phase which should then be followed by a decline in the spawning-phase in 1987.

A. Nest Counts

Whereas the early values from nest counts seemed to convincingly document the impact of the initial 1971-72 lampricide treatments, recent nest counts are variable and difficult to infer trends from (Table 9). In general, 1987 counts increased to the east and decreased to the west although the entire span of Lake Ontario coastline represented by the surveyed streams is only about 50 miles.

Note that three streams were added to the survey schedule in 1985 in an effort to compensate for nest counts not done because of concurrent lampricide treatments, and increase the effective data points.

B. Dam Traps and Portable Assessment Traps

Overall trap catches in New York streams were low in 1987, but not lower than the most recent two years (Table 10). One tendency apparent in the recent catches in New York streams is a reduction in catches in streams to the west, which is consistent with nest counts. Whereas New York catches were low, 1987 catches in Canadian streams increased in every case except Shelter Valley Brook in which a September 1986 lampricide treatment may have retarded the 1987 spawning run. Thus, those catches are contrary to other indices and difficult to explain.

C. Length, Weight and Sex Ratio

Since initiation of the lampricide program on Lake Ontario, the sex ratio has failed to trend toward femaleness as upper Great Lakes sea lampreys have done as an apparent response to population stress caused by the control programs in those lakes (Table 11; Heinrich, et al 1980). This lack of femaleness trend in Lake Ontario sea lampreys has been even further exaggerated in recent years and now the percent males in the spawning population is higher than pre-control. The implication of this is that either Lake Ontario sea lampreys are reacting differently to control, or substantial recruitment from untreated stocks is occurring.

ANALYSIS

Using the fundamental relationship of sea lampreys, salmonids and wounding, the salmonid increase resulting from the stocking program and lake trout survival improvement would be expected to reduce wounding if sea lampreys remained stable. Wounding did not decrease and could even have increased slightly in 1987. That an increase in sea lampreys occurred in 1987 is supported by some of the direct evidence although that is not convincing. And, it is not consistent with the continued improvement in lake trout survival that was measured in 1987 (C.P. Schneider, pers. comm[1]). Furthermore, Black River was retreated in 1987 and two newly detected infestations are scheduled for lampricide treatment in 1988. These are probable sources of some of the 1987 recruitment, so the outlook is for some further attrition of parasitic phase sea lamprey abundance in 1988 and 1989. While there ar still some apparent negative features being exhibited by the sea lamprey population such as the trend toward maleness, it is also quite apparent that a favorable lamprey/salmonid balance has been reached. Therefore, it seems obviously prudent to maintain this balance by aggressive pursuit of the lampricide program including new infestations.

[1] New York State Dept. Environmental Conservation, Cape Vincent, N.Y.

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TABLE 1. Sea lamprey wounding rates for adult coho taken by OMNR from the Credit River in the fall, Lake Ontario, Canada. Wounds: Stages I and II; Scars: Stages III and IV and Type B.

Year	n	Mean Fork Length mm (in)	Mean Total Length mm (in)	Weight g (lb)	# Wounds per Fish	% Wounding	# Scars per Fish	% Scarring	Total Marks per Fish	% Marking
1970	126	576 (22.7)	612 (24.1)	2291 (5.1)	3.02	92.9	3.29	96.8	6.31	100.0
1971	367	591 (23.3)	627 (24.7)	2250 (4.9)	2.16	77.7	3.62	96.7	5.77	99.5
1972	439	584 (23.0)	608 (23.9)	2358 (5.2)	1.01	66.5	3.21	95.9	4.23	98.6
1973	163	587 (23.1)	620 (24.4)	2461 (5.4)	0.96	60.1	2.02	83.4	2.98	92.0
1974	1726	646 (25.4)	658 (25.9)	3650 (8.0)	1.18	69.4	3.27	93.2	4.45	97.8
1975	921	669 (26.3)	708 (27.9)	3954 (8.7)	0.73	50.1	1.29	73.4	2.02	90.2
1976	304	680 (26.8)	723 (28.5)	4439 (9.8)	0.50	38.2	1.16	65.1	1.66	76.6
1977	345	664 (26.1)	701 (27.6)	4074 (9.0)	0.07	6.7	0.16	14.2	0.23	20.0
1978	310	684 (26.9)	727 (28.6)	4593(10.1)	0.05	4.8	0.24	18.4	0.29	22.6
1979	513	704 (27.7)	744 (29.3)	5392(11.9)	0.05	5.1	0.24	18.1	0.30	21.6
1980	312	658 (25.9)	ND	4200 (9.3)	0.06	4.8	0.14	12.5	0.21	17.3
1981	130	654 (25.7)	ND	4590(10.1)	0.02	2.3	0.06	4.6	0.09	6.2
1982	559	672 (26.5)	ND	4499 (9.9)	0.05	4.8	0.07	6.4	0.12	10.9
1983	342	692 (27.2)	732 (28.8)	4600(10.0)	0.003	0.3	0.05	4.4	0.06	4.7
1984	314	651 (25.6)	ND	4016 (8.8)	0.02	1.6	0.05	5.1	0.07	6.7
1985	282	677 (26.7)	718 (28.3)	4500 (9.9)	0.01	1.4	0.03	2.8	0.04	4.2
1986	332	664 (26.1)	705 (27.8)	3605 (7.9)	0.003	0.3	0.02	2.1	0.02	2.4
1987	354	668 (26.3)	713 (28.1)	9207 (9.3)	0.01	1.1	0.01	1.4	0.03	2.5

TABLE 2. Sea lamprey lesions on coho and chinook salmon and steelhead trout collected during the fall spawning migration from Salmon River, New York. Samples were collected by estuarial gill netting and creel census with Salmon River Hatchery processing added in 1983.

	Sample Year	Average Total Length Inches (mm)	Type A Stages II-IV & Type B (Scars) Per Fish	Type A Stage I (Wounds) per Fish	Total Marks per Fish	Incidence of Attack %	Sample size
Chinook I+	1971	22.1 (561)	5.71	0.43	6.14	100	7
	1972	22.2 (564)	4.59	0.30	4.89	98	277
	1973	21.9 (556)	1.42	0.15	1.57	70	347
	1974	22.8 (579)	0.78	0.09	0.87	51	253
	1975	23.9 (607)	0.39	0.11	0.50	34	90
	1976	25.0 (635)	0.39	0.04	0.43	32	167
	1977	24.6 (625)	0.21	0.03	0.24	14	66
	1979	22.7 (577)	0.20	0.00	0.20	20	15
	1980	24.8 (631)	0.25	0.08	0.34	25	12
	1981	25.1 (638)	0.082	0.00	0.08	8	159
	1982	24.9 (633)	0.14	0.00	0.14	13	121
	1983	24.7 (627)	0.027	0.00	0.027	3	75
	1984	24.3 (617)	0.039	0.00	0.039	4	208
	1985	25.0 (634)	0.019	0.002	0.021	2	580
	1986	23.9 (608)	0.022	0.00	0.022	2	273
	1987	24.2 (614)	0.013	0.00	0.013	1	232
Coho II+	1971	24.4 (620)	9.28	0.59	9.86	100	53
	1972	23.5 (597)	7.19	1.00	8.19	96	53
	1973	23.6 (599)	3.11	0.30	3.41	89	123
	1974	26.2 (666)	2.08	0.75	2.85	93	71
	1975	28.2 (716)	1.37	0.57	1.94	82	192
	1976	28.1 (714)	1.69	0.39	2.07	82	67
	1977	29.5 (749)	0.50	0.06	0.56	41	270
	1978	29.2 (742)	0.65	0.06	0.71	51	271
	1979	29.0 (737)	0.58	0.01	0.59	42	80
	1980	31.0 (788)	0.73	0.13	0.86	58	106
	1981	29.7 (756)	0.29	0.03	0.32	26	34
	1982	29.4 (746)	0.56	0.05	0.61	41	39
	1983	27.8 (707)	0.054	0.0045	0.059	5	222
	1984	27.6 (701)	0.058	0.00	0.058	6	121
	1985	28.1 (715)	0.057	0.002	0.059	6	630
	1986	27.4 (697)	0.042	0.00	0.042	4	578
	1987	27.8 (706)	0.11	0.009	0.12	11	234
Steelhead II+	1975	25.9 (658)	0.95	0.06	1.00	62	134
	1977	26.3 (668)	0.31	0.00	0.31	22	36
	1979	26.6 (676)	0.32	0.05	0.36	29	22
	1980	26.8 (682)	0.24	0.06	0.30	21	33
	1982	26.8 (680)	0.68	0.06	0.71	54	28
	1983	26.0 (660)	0.057	0.00	0.057	6	35
	1985	26.9 (684)	0.054	0.00	0.054	5	37
	1986	27.1 (689)	0.095	0.00	0.095	10	21
	1987	25.3 (643)	0.20	0.00	0.20	15	20

TABLE 3. Incidence of any type of sea lamprey attack on age II coho salmon and brown trout taken in the spring in nearshore Canadian and U.S. waters of Lake Ontario. Canada (OMNR) samples were collected by gill nets in the Niagara area. U.S. (DEC) samples were by gill netting from 1974 to 1978 and 1983, combination of gill netting and sport derby monitoring 1979 to 1981, and a sport derby alone in 1982, 1984, 1985, 1986, and 1987. OMNR coho sampling at Niagara was discontinued after 1984.

		Percent Attacked (Sample Size)													
Source	Species/Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
OMNR	Coho II	ND	29.4 (909)	14.9 (827)	2.9 (350)	1.4 (511)	3.7 (512)	2.8 (505)	1.6 (382)	10.3 (458)	1.0 (491)	3.1 (455)	NA	NA	NA
DEC	Coho II	41.5 (371)	34.0 (282)	22.7 (128)	4.9 (81)	5.2 (347)	5.7 (856)	7.0 (2215)	4.1 (483)	11.4 (334)	2.9 (173)	2.9 (633)	2.3 (865)	1.4 (561)	1.6 (126)
DEC	Brown Trout II	45.2 (168)	46.7 (210)	29.7 (219)	21.7 (258)	21.6 (496)	29.2 (1262)	32.9 (2377)	23.5 (3277)	19.4 (4455)	12.8 (290)	4.5 (668)	7.6 (1336)	5.0 (1274)	8.3 (315)

Table 4. Number of Type A Stage I, II and III wounds per 100 lake trout for four size groups* and four geographic zones in Lake Ontario, 1978 - 1986. Sample sizes in parenthesis. U.S. waters, gill net, September.

Year	GEOGRAPHICAL ZONE: Niagara Size Group 1	Niagara 2	Niagara 3	Niagara 4	Rochester 1	Rochester 2	Rochester 3	Rochester 4	Oswego 1	Oswego 2	Oswego 3	Oswego 4	East. Basin 1	East. Basin 2	East. Basin 3	East. Basin 4
1978	5.0 (121)	17.5 (97)	25.0 (8)	-	-	-	-	-	11.1 (9)	41.2 (17)	66.7 (3)	-	10.2 (59)	29.7 (74)	22.6 (53)	-
1979	3.0 (33)	19.5 (87)	33.3 (12)	-	2.7 (37)	15.6 (77)	12.5 (8)	-	10.0 (10)	50.8 (59)	58.3 (24)	-	28.6 (14)	23.3 (116)	37.8 (90)	42.9 (7)
1980	1.5 (66)	24.1 (29)	50.0 (16)	-	9.1 (22)	14.3 (7)	0 (4)	-	33.3 (30)	33.3 (6)	33.3 (9)	-	13.8 (29)	29.9 (67)	30.7 (127)	13.3 (15)
1981	4.5 (44)	14.8 (81)	22.2 (9)		4.0 (25)	8.3 (24)	-	-	0 (26)	35.1 (57)	41.7 (12)	-	2.3 (43)	17.5 (63)	12.0 (75)	8.0 (25)
1982	6.0 (151)	26.8 (82)	50.0 (28)	-	13.3 (30)	23.3 (43)	40.0 (20)	-	4.2 (48)	58.0 (50)	88.2 (34)	-	11.1 (27)	38.3 (60)	78.0 (59)	52.4 (21)
1983	2.9 (136)	9.9 (203)	37.8 (90)	-	2.2 (46)	18.4 (125)	31.8 (66)	66.7 (3)	2.4 (123)	26.2 (172)	58.7 (109)	-	0 (65)	15.1 (106)	36.1 (72)	7.7 (39)
1984	0 (168)	5.7 (122)	28.5 (151)	0 (8)	1.5 (65)	16.3 (86)	22.7 (76)	0 (3)	3.0 (100)	9.8 (112)	44.5 (119)	50.0 (8)	0 (23)	9.5 (95)	21.6 (88)	14.0 (43)
1985	0 (100)	5.7 (122)	17.8 (157)	0 (9)	0 (60)	37.3 (110)	52.8 (127)	169.2 (13)	2.0 (49)	29.5 (61)	80.6 (93)	145.5 (11)	3.4 (29)	24.0 (104)	53.1 (162)	62.5 (16)
1986	2.0 (152)	3.5 (113)	15.8 (291)	18.5 (54)	1.3 (80)	11.0 (100)	28.6 (217)	42.6 (35)	0 (47)	12.7 (79)	44.1 (227)	85.7 (49)	0 (27)	11.5 (87)	37.6 (229)	27.6 (29)
1987	0 (107)	4.0 (101)	17.4 (195)	25.6 (39)	0 (48)	0.9 (105)	42.9 (112)	67.6 (37)	0 (43)	9.2 (109)	34.2 (202)	79.1 (43)	0 (35)	16.5 (115)	39.4 (246)	34.9 (43)

* Size Group Legend 1 = 431 - 531 mm (17.0 - 20.9 inches); 2 = 532 - 633 mm (21.0 - 24.9 inches); 3 = 634 - 735 mm (25.0 - 28.9 inches); 4 = 736 mm and over (29.0 + inches)

TABLE 5. Sea lamprey wounds and scars on lake trout taken in July from Canadian waters of Eastern Outlet Basin, Lake Ontario, 1977 - 1987. Wound is Stage I, Scar is Stage II - IV.

Size Class fork length mm	Year	Number of fish	CUE[a]	Number wounded	Freq. wounds	Wound[b] index	Number scarred	Freq. scars	Scar[c] index
305 - 405 mm (12-15.9 in)	1977	8	0.67	0	0	0.00	0	0	0.00
	1978	75	6.25	1	1	0.08	1	1	0.08
	1979	63	5.87	2	2	0.19	1	1	0.09
	1980	58	12.40	0	0	0.00	0	0	0.00
	1981	98	11.88	0	0	0.00	0	0	0.00
	1982	44	7.83	0	0	0.00	0	0	0.00
	1983	201	26.72	1	1	0.13	4	4	0.53
	1984[d]	22	22.00	0	0	0.00	0	0	0.00
	1985	93	16.00	0	0	0.00	1	1	0.24
	1986	143	25.33	1	3	0.53	0	0	0.00
	1987	131	24.13	0	0	0.00	0	0	0.00
406 - 507 mm (16-19.9 in)	1977	41	3.42	2	3	0.25	6	8	0.67
	1978	83	6.92	6	6	0.50	6	9	0.75
	1979	125	11.65	5	5	0.47	14	16	1.49
	1980	90	16.30	2	2	0.36	12	12	2.17
	1981	145	8.99	1	1	0.06	9	10	0.62
	1982	77	13.16	4	4	0.68	5	8	1.37
	1983	207	28.04	0	0	0.00	20	20	2.71
	1984[d]	82	85.00	0	0	0.00	1	1	1.04
	1985	196	34.17	2	3	0.52	6	7	1.22
	1986	163	28.17	1	1	0.17	0	0	0.00
	1987	147	27.08	0	0	0.00	2	2	0.37
507 - 609 mm (20-23.9 in)	1977	7	0.58	0	0	0.00	1	1	0.08
	1978	9	0.75	1	1	0.08	3	6	0.50
	1979	61	5.11	6	6	0.50	16	20	1.68
	1980	116	21.06	11	12	2.18	44	50	9.08
	1981	102	7.77	1	1	0.08	26	35	2.67
	1982	37	6.16	1	1	0.17	14	18	3.00
	1983	193	25.06	16	16	2.08	96	137	17.79
	1984[d]	140	140.00	3	5	5.00	7	11	11.00
	1985	438	79.50	19	19	3.45	136	194	35.21
	1986	251	44.33	12	12	2.12	32	40	7.06
	1987	116	21.37	1	1	0.18	84	109	20.08
610 - 711 mm (24-27.9 in)	1977	0	0.00						
	1978	0	0.00						
	1979	2	0.17	0	0	0.00	0	0	0.00
	1980	6	1.02	2	2	0.34	2	2	0.34
	1981	12	0.82	0	0	0.00	3	3	0.21
	1982	8	1.33	1	1	0.17	4	6	1.00
	1983	7	0.78	0	0	0.00	7	11	1.22
	1984[d]	22	22.00	1	2	2.00	5	9	9.00
	1985	93	16.00	9	10	1.72	59	117	20.13
	1986	82	14.17	12	13	2.25	30	38	6.57
	1987	246	45.32	0	0	0.00	78	146	26.90

a CUE - catch per 100 yeards of 1½ - 6 inch mesh, ½ inch intervals by size class
b Wound index - wounds/fish x CUE
c Scar index - scars/fish x CUE
d 1984 - one life only (Area IV)

TABLE 6. Lake Trout Wounding (Stage I) and Scarring (Stages II, III, and IV) August Cruise (Eastern Outlet), Canada, 1978 - 1987.

Size Class fork length mm	Year	Number of fish	CUE[a]	Number wounded	Percent wounded	Number of wounds	Wound[b] index	Number scarred	Percent scarred	Number of scars	Scar[c] Index
305 - 405 mm (12-15.9 in)	1978	59	5.50	1	1.7	1	0.09	0	0.0	0	0.00
	1979	22	1.86	0	0.0	0	0.00	0	0.0	0	0.00
	1980	10	1.79	0	0.0	0	0.00	0	0.0	0	0.00
	1981	25	5.01	0	0.0	0	0.00	0	0.0	0	0.00
	1982	62	8.24	0	0.0	0	0.00	0	0.0	0	0.00
	1983	63	13.76	0	0.0	0	0.00	0	0.0	0	0.00
	1984	68	12.58	0	0.0	0	0.00	0	0.0	0	0.00
	1985	85	16.67	0	0.0	0	0.00	0	0.0	0	0.00
	1986	90	18.55	0	0.0	0	0.00	1	1.1	1	0.20
	1987	61	11.66	0	0.0	0	0.00	0	0.0	0	0.00
406 - 507 mm (16-19.9 in)	1978	96	9.75	8	8.3	11	1.12	1	1.0	1	0.10
	1979	69	5.84	9	13.0	9	0.76	5	7.3	6	0.51
	1980	10	1.79	0	0.0	0	0.00	1	10.0	1	0.18
	1981	20	4.11	0	0.0	0	0.00	0	0.0	0	0.00
	1982	125	14.51	2	1.6	2	0.23	4	3.2	4	0.46
	1983	97	20.86	0	0.0	0	0.00	10	10.3	12	2.58
	1984	134	23.92	2	1.5	4	0.71	3	2.2	3	0.54
	1985	48	9.00	0	0.0	0	0.00	0	0.0	0	0.00
	1986	51	10.68	0	0.0	0	0.00	2	3.9	2	0.41
	1987	56	10.71	1	1.8	1	0.19	0	0.0	0	0.00
508 - 609 mm (20-23.9 in)	1978	8	0.67	0	0.0	0	0.00	2	25.0	2	0.17
	1979	36	3.05	5	13.9	6	0.51	14	38.9	17	1.44
	1980	27	5.37	1	3.7	1	0.20	12	44.4	20	3.98
	1981	32	6.25	0	0.0	0	0.00	6	18.8	10	1.95
	1982	86	10.33	1	1.2	1	0.12	39	45.3	65	7.81
	1983	178	39.00	7	3.9	8	1.75	106	59.6	161	35.27
	1984	286	52.00	12	4.2	14	2.55	79	27.6	101	18.36
	1985	185	32.83	1	0.5	1	0.18	61	33.0	86	15.26
	1986	161	36.92	10	6.2	10	2.29	28	17.4	35	8.02
	1987	373	71.32	9	2.4	14	2.68	133	35.7	184	35.18

a CUE - catch per 100 yards of 1½ - 6 inch mesh, ½ inch intervals by size class.
b Wound Index - Wounds/fish x CUE
c Scar Index - Scars/fish x CUE

TABLE 7. Sea lamprey wounds and scars on lake trout taken in 1.5 - 6.0 inch gill nets in midsummer from three transects [Grape Is., Flat Pt. and Mellville Sh.] at six depths [2.5 - 27.5 M at 5 M intervals] in Eastern Outlet Basin, Lake Ontario, Canada.

Size Class fork length	Year	Number of fish	CUE[a]	Number wounded	Frequency wounds	Wound index[b]	Number scarred	Frequency scars	Scar index[c]
305-405 mm.	1986	37	1.46	0	0	0	0	0	0
(12-15.9 in.)	1987	14	0.56	0	0	0	1	3	.12
406-507 mm.	1986	63	2.48	0	0	0	2	2	.08
(16-19.9 in.)	1987	20	.81	0	0	0	2	2	.08
508-609 mm.	1986	310	12.22	4	4	.15	36	38	1.50
(20-23.9 in.)	1987	184	7.42	6	6	.24	58	73	2.94
610-711 mm.	1986	167	6.58	6	8	.32	48	68	2.68
(24-27.9 in.)	1987	130	5.25	1	1	.04	82	141	5.69

a CUE - catch per 100 yds of 1½ - 6 inch mesh, ½ inch intervals by size class
b Wound index - wounds/fish x CUE
c Scar index - scars/fish x CUE

TABLE 8. ESLO spring sea lamprey collections, Lake Ontario. Voluntary specimen donations were solicited by GLFC and collected by NYDEC personnel during each 4-day derby. Stations listed in East to West order.

Check Station	# Derby Fish Checked					# Lampreys Turned IN					# Lampreys per 1000 Derby Fish				
	1983	1984	1985	1986	1987	1983	1984	1985	1986	1987	1983	1984	1985	1986	1987
Henderson	NO	NO	538	985	153	-	-	5	7	4	-	-	9.3	7.1	26.1
Sandy Pond	1052	631	432	1096	115	2	8	3	6	11	1.9	12.7	6.9	5.5	95.7
Mexico Point	NO	NO	NO	967	688	-	-	-	6	7	-	-	-	6.2	10.2
Oswego	1010	783	580	599	538	10	14	9	1	2	9.9	17.9	15.5	1.7	3.7
Fair Haven	1422	1303	1305	1141	515	18	12	10	5	10	12.7	9.2	7.7	4.4	19.4
Sodus	2476	3252	1871	1442	1143	33	22	18	12	11	13.3	6.8	9.6	8.3	9.6
Rochester	1236	2264	2132	1466	507 (313)	6	27	16	13	7*	4.9	11.9	7.5	8.9	22.4
Braddocks	1009	2600	2370	1258	625	6	NS	21	2	5	6.0	-	8.9	1.6	8.0
Oak Orchard	1178	1989	3467	1225	468	7	19	35	6	3	5.9	9.6	10.1	4.9	6.4
Olcott	NO	NO	NO	649	506	-	-	-	5	9	-	-	-	7.7	17.7
Wilson	2080	1749	2213	609	628	13	42	19	2	18	6.3	24.0	8.6	3.3	28.7
Totals	**11,463**	**14,571 (11,971)**	**14,908**	**14,473**	**5,978 (5,694)**	**95**	**144**	**136**	**65**	**87**	**8.3**	**12.0**	**9.1**	**5.7**	**15.3**

* = Lamprey sample not collected the last 2 days of the derby at this station
NO = Station not operating
NS = No lamprey sample collected
Derby dates: April 28 - May 1, 1983; April 26 - 29, 1984; April 25 - 28, 1985; April 24 - 27, 1986; April 23 - 26, 1987

TABLE 9. Sea lamprey nest counts on standardized sections of contiguous Lake Ontario tributaries and a tributary of Oneida Lake, all in New York.

	Contiguous Lake Ontario Streams									Oneida Lake Tributary	
	S. Sandy Cr.	Skinner Cr.	Lindsey Cr.	L. Sandy Cr.	Orwell Br.	Trout Br.	John O'Hara Br.	Beaverdam Cr.	Grindstone Cr.	Sterling Cr.	W. Br. Fish Cr.
Section Length Miles	1.3	4.2	2.1	1.6	2.2	2.2	1.5	0.5	2.0	1.2	4.5
1971	ND	411	158	223	162	ND	ND	ND	97	73	ND
1972	ND	CT	CT	CT	CT	ND	ND	ND	CT	CT	ND
1973	ND	CT	CT	CT	CT	ND	ND	ND	CT	CT	ND
1974	ND	49	24	9	3	ND	ND	ND	11	49	ND
1975	ND	226	26	33	CT	ND	ND	ND	CT	CT	ND
1976	ND	EHW	EHW	EHW	EHW	ND	ND	ND	EHW	EHW	ND
1977	ND	272	81	89	25	ND	ND	ND	43	49	ND
1978	ND	392	42	106	CT	ND	ND	ND	107	82	ND
1979	ND	133*	36*	CT	31	ND	ND	ND	210**	CT	ND
1980	CT	CT	CT	44	82	ND	ND	ND	168	95	45
1981	84	EHW	EHW	42	CT	ND	ND	ND	377	233	30
1982	154	76	36	CT	15	ND	ND	ND	CT	CT	21
1983	836	CT	CT	139	CT	ND	ND	ND	493	206	24
1984	ND	122	68	136	12	ND	ND	ND	427	198	CT
1985	120*	92*	54*	CT	22	98	39	63	CT	CT	54
1986	141*	70*	55*	61	CT	CT	CT	CT	319	66	15*
1987	CT	265	254	CT	10	31	15	1	CT	56	22

Legend: ND = Not done
CT = Not done because of concurrent chemical treatments
EHW = Not done because of erosion by high water
* = Count possibly biased downward because of high water
** = Count possibly biased downward because of adults in PAT's were removed

TABLE 10. Numbers of spawning-run lampreys collected in Dam Traps (DT) and Portable Assessment Traps (PAT) operated under the direction of DFO and FWS in selected Ontario and New York tributaries of Lake Ontario, 1978 - 1987. New York catches were adjusted by spawning-run peaks and temperature to compensate for lampricide treatments during run. Adjusted numbers are in parenthesis.

Stream	Gear	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Ontario											
Graham Creek	(DT)	60**	168	160	32**	67	ND	26	672	122*	224**
Humber River	(DT)	ND	ND	104	608***	876	4625***	1366	2828	2069	4870
Bowmanville Creek	(PAT)	109*	62**	28*	182**	309	100	242	466	155*	641**
Wilmot Creek	(PAT)	14*	15**	67*	107**	80	566	9	58	93*	133**
Shelter Valley Cr.	(DT)	6**	152	12*	14**	144	ND	14*	123**	2531***	905**
Duffin Creek	(DT)	ND	ND	ND	293**	149	606	520	1059	615**	1320
Lakeport Creek	(DT)	ND	ND	ND	ND	ND	ND	ND	47	42	97
TOTAL ONTARIO		-	-	-	**1,236**	**1,625**		**2,177**	**5,253**	**5,627**	**8,190**
New York											
Sterling Creek	(PAT)	ND	ND	28	125	361 (412)	174**	43	85 (141)	77**	25
Sterling Valley Cr.	(PAT)	ND	ND	324	218	422 (626)	461**	427	258 (427)	412**	304
Catfish Creek	(PAT)	65	360	29 (50)	11**	10	11	2	0**	2	1 (2)
Little Salmon R.	(PAT)	242	673 (910)	47**	113	316	7**	2	52	4**	1
Grindstone Ck.	(PAT)	315	623**	311	210	255 (350)	678**	138	70 (175)	69**	56 (69)
South Sandy Cr.	(PAT)	ND	ND	ND	ND	ND	ND	ND	1	10	114
TOTAL NEW YORK		-	**1,656**	**739**	**677**	**1,364**	**1,331**	**602**	**466**	**574**	**501**
			(1,893)	**(760)**		**(1,714)**			**(796)**		**(515)**

* Stream treated with lampricide during spawning run
** Stream treated with lampricide the previous year
ND Not Done
*** Trapping system modified and/or relocated

TABLE 11. Biological statistics of spawning-run sea lampreys captured by dip netting (N), weirs (W) and trapping (T) and by routine chemical treatments (CT) under contract to DFO and FWS in Humber River and other tributaries to Lake Ontario in Ontario and New York.

Year	Number Collected	Number Sampled	% Males	Mean Length cm (in) Males	Females	Mean Weight g (oz) Males	Females
Humber River (N)							
1968	1221	1221	50.1	43.1 (17.0)	40.9(16.1)	164(5.8)	161(5.7)
1969	1335	1335	50.7	42.0 (16.5)	42.0(16.5)	170(6.0)	175(6.2)
1970	2185	2177	53.0	41.1 (16.4)	41.1(16.4)	156(5.5)	167(5.9)
1971	2450	1488	55.7	41.0 (16.1)	41.0(16.1)	155(5.5)	165(5.8)
1972	4615	4395	55.3	41.0 (16.5)	42.0(16.5)	149(5.3)	159(5.6)
1973	6308	5065	55.1	41.0 (16.1)	42.0(16.5)	157(5.5)	170(6.0)
1974	3350	2727	58.4	42.0 (16.5)	42.0(16.5)	166(5.9)	176(6.2)
1975	6848	1296	53.5	44.0 (17.1)	44.0(17.1)	187(6.6)	204(7.2)
1976	4030	885	56.9	46.0 (18.1)	45.0(17.7)	230(8.1)	239(8.4)
1977	1601	489	53.8	47.0 (18.5)	47.0(18.5)	240(8.5)	248(8.8)
1978	2453	339	42.0	44.0 (17.1)	45.0(17.7)	207(7.3)	224(7.9)
Ontario							
1977	- (T)	169	56.5	48.8 (19.2)	47.8(18.8)	271(9.6)	271(9.6)
1978	- (T&W)	326	48.0	48.0 (18.9)	47.0(18.5)	260(9.2)	237(8.4)
1979	- (T&W)	317	56.0	48.0 (18.9)	48.0(18.9)	272(9.6)	282(10.0)
1980	384(T&W)	353	55.0	49.0 (19.3)	49.3(19.3)	245(8.6)	253(8.9)
1981	1239(TW&N)	1239	58.0	47.0 (18.5)	47.0(18.5)	240(8.5)	247(8.7)
1982	1625(TW&N)	1440	53.4	49.0 (19.3)	48.0(18.9)	242(8.5)	244(8.6)
1983	5898(T)	2740	60.0	45.8 (18.0)	45.5(17.9)	217(7.7)	227(8.0)
1984	2177(T&W)	1081	55.0	49.4 (19.5)	48.4(19.1)	264(9.3)	267(9.4)
1985	5253(T&W)		63.2	48.6 (19.1)	47.8(18.8)	247(8.7)	249(8.8)
1986	5627(T&W)	1768	64.9	50.2 (19.8)	49.7(19.6)	267(9.4)	273(9.6)
1987	8190(T&W)	1711	61.0	49.4 (19.4)	48.4(19.1)	272(9.6)	269(9.5)
New York							
1978	- (T)	211	52.1	--------46.4 (18.3)------		------226 (8.0)------	
1979	- (T)	1548	51.6	48.8 (19.2)	48.5(19.1)	262(9.2)	264(9.3)
1979	- (CT)	305	60.0	47.0 (18.5)	47.0(18.5)	262(9.2)	259(9.1)
1980	- (CT)	342	56.0	48.3 (19.0)	48.1(18.9)	254(8.6)	254(9.0)
1981	- (T)	212	61.0	47.8 (18.8)	48.6(19.1)	261(9.2)	263(9.3)
1982	1364(T)	1364	60.0	49.7 (19.6)	48.6(19.1)	255(9.0)	257(9.1)
1983	1331(T)	480	63.0	48.7 (19.2)	48.3(19.0)	243(8.6)	248(8.7)
1984	602(T)	431	56.0	49.3 (19.4)	48.5(19.1)	286(10.1)	282(9.9)
1985	466(T)	311	62.0	48.8 (19.2)	48.0(18.9)	269(9.5)	265(9.3)
1986	574(T)	525	68.0	49.1 (19.3)	48.7(19.2)	269(9.5)	268(9.5)
1987	501(T)	423	74.0	50.1 (19.7)	49.8(19.6)	212(7.5)	213(7.5)

Great Lakes Fishery Commission
Lake Ontario Committee
Gananoque, Ontario
March 8-9, 1988

MONITORING COHO SPAWNING RUN IN THE CREDIT RIVER

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ABSTRACT

Coho were sampled during the spawning run in the Credit River over the period from November 23-30, 1987. The adult fish represented the third generation of the Capalino River (British Columbia) strain to complete their life cycle in Lake Ontario (Table 1). The returning year class originated from a planting of 90,000 yearlings in the Credit River in 1986 (Table 2). Lamprey marking remained at at a low level of 2.5 % (Table 3, Figure 1). Returning adult fish averaged 4702 grams in weight. Male coho weighed significantly more than female coho (Mann-Whitney U test, $P < .0001$). Returns of jacks consisted of two fall plantings; an early release of 73,000 fish exhibiting signs of bacterial kidney disease (BKD) and a later stocking of 17,000 surplus fish (Table 2). There was no difference in the size of returning jacks from these two stockings. The ratio of catch/1000 stocked was 0.47 and 0.26 for the surplus stocking and the BKD stocking, respectively. The majority (98%) of the adult fish originated from the 1986 planting of the Capalino River strain. Fin clip regeneration was low on these fish (Table 5). Only one fish was considered a stray, most likely from a Bronte creek planting. Other clips observed probably represent observational or clipping errors. There is an indication of a trend to smaller weight in recent years (Figure 2b). A test of this hypothesis will require a partitioning of variance between strain, sex, spawning condition, and generation time.

RECOMMENDATIONS

1) Maintain monitoring of the coho egg taking operations.

2) Increase the precision of weight measurements to the nearest 25 grams.

3) Test the hypothesis of a decrease in spawning weight by analysis of variance partitioning variance among strain, sex, spawning condition, and generation time.

TABLE 1: Comparison of peak spawning dates for 3 strains of coho returning to the Credit River

	SKAGIT R. (Washington)	CAPILANO R. (B.C.)	BIG QUALICUM R. (B.C.)
PARENT SPAWNING DATES	late Nov. - early Dec.	early Nov. - Dec.	mid-Oct. - Dec.

Year of Return	Egg Collection Dates	Year of Return	Egg Collection Dates	Year of Return	Egg Collection Dates
1977	early to late Nov.	1978	late Nov.	1979	late Nov.
1980	early to mid-Nov.	1981	mid-Nov. to early Dec.	1982	mid to late Nov.
1983	early Dec.	1984	late Nov. (some late Dec.)	1985[1]	late Nov. to mid-Dec.
1986	late Nov. to early Dec.	1987	late Nov.		

NOTE:

1977 - 1979: return of fish raised from eyed eggs imported from 3 western sources and planted in Lake Ontario.

1980 - 1982: return of 1st generations of these strains to complete their life cycle in Lake Ontario.

1983 - 1985: return of 2nd generations.

1986 - 1988: return of 3rd generations.

[1]hormone injections given to some of the fish to accelerate maturation - fish held in fishway until ripe.

Table 2: Coho returning in 1987.

Year of Stocking	Age in 1987	Stocking Site	# Stocked	Size at Stocking (#/lb)	Fin Clip
1985 (fall planting)	2+	Selkirk Park	25,000	10	LP
1986	2+	Credit River	90,000	20	RV
		Bronte Creek	43,000	20	RP
		Port Dalhousie	50,000	21	RP
	2+	NY - various	169,000	17-10	NC
		Salmon River	25,000	10	LV
Totals	2+		402,000		
1986 (spring planting)	1+	Salmon River	85,000	85	NC
1986 (fall plantings)	1+	Credit River	73,000 (BKD)	29	Ad
		Credit River	17,000 (surplus)	41	Ad-RP
		Salmon River	269,000	21-15	NC
1987	1+	Credit River	48,000	19(23g)	Ad
		Bronte Creek	71,000	23	RV
		Port Dalhousie	68,000	24	RV
	1+	NY	81,000 (est.)	not available	
Totals	1+		648,000		

Table 3: Lamprey marking on adult coho (FL > 400 mm) from the 1987 egg collection from the Credit River (N = 354)

Type	Stage	# Marks	Mean Diameter (mm)
A	I	0	0
	II	4	18.5
	III	0	0
	IV	0	0
B	I	1	30
	II	0	0
	III	3	26
	IV	1	37

Total # marks	9
Total # marked fish	9
Marking rate [1]	2.54
Incidence of attack [2]	2.54%
Total # wounds (AI-II)	4
Wounding rate	1.13%
Total # scars (AIII-IV, BI-IV)	5
Scarring rate	1.41%

[1] Marking rate = $\frac{\text{total \# marks observed}}{\text{total \# fish sampled}} \times 100$

[2] Incidence of attack = $\frac{\text{\# fish with 1 or more marks}}{\text{total \# fish sampled}} \times 100$

TABLE 4: Summary statistics for coho from the 1987 egg collection (Credit River)

ADULTS (FL > 440 mm)

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	354	712	482	823	43.95	2.33
FL (mm)	354	669	454	782	42.00	2.23
WT (g)*	353	4,207	1,000	6,250	792.64	42.18

JACKS (FL < 440 mm)

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	30	405	305	470	35.30	6.45
FL (mm)	30	376	279	440	35.08	6.41
WT (g)*	30	908	500	1,250	191.22	34.91

ADULT MALES

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	151	729	538	823	42.11	3.43
FL (mm)	151	684	493	782	41.95	3.41
WT (g)*	150	4,372	1,500	6,250	838.33	68.45

ADULT FEMALES

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	202	701	482	797	41.26	2.90
FL (mm)	202	658	454	748	38.58	2.71
WT (g)*	202	4,089	1,000	5,750	736.41	51.81

HATCHERY EXCESS (Returning as jacks, Ad-Rp clip)

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	8	418	352	470	38.35	13.56
FL (mm)	8	388	324	440	37.96	13.42
WT (g)*	8	1,031	500	750	160.22	56.66

EARLY BKD STOCKING (Returning as jacks, Ad clip)

Attribute	N	Mean	Min.	Max.	St. Dev.	St. Error
TL (mm)	19	399	304	442	36.26	8.32
FL (mm)	19	371	279	415	36.10	8.28
WT (g)*	19	855	500	1,250	192.13	44.08

* weights recorded to the nearest 250 g

Table 5: Fin clip frequency and regeneration as a percentage of the Canadian coho sampled from the 1987 spawning run in the Credit River (double clip % regeneration was recorded as the average regeneration of the two clipped fins)

% Regeneration*	Adults		Jacks			
	RV	RP	RP	Ad	RPAD	LPAD**
0	54.7	100.0	0.0	26.3	0.0	0.0
0 - 50	34.0	0.0	100.0	68.42	100.0	100.0
50 - 90	9.9	0.0	0.0	5.2	0.0	0.0
90 +	1.5	0.0	0.0	0.0	0.0	0.0
N	344	1	1	19	8	2

* determined qualitatively

** assumed to be mis-clipped or mis-identified Canadian fish

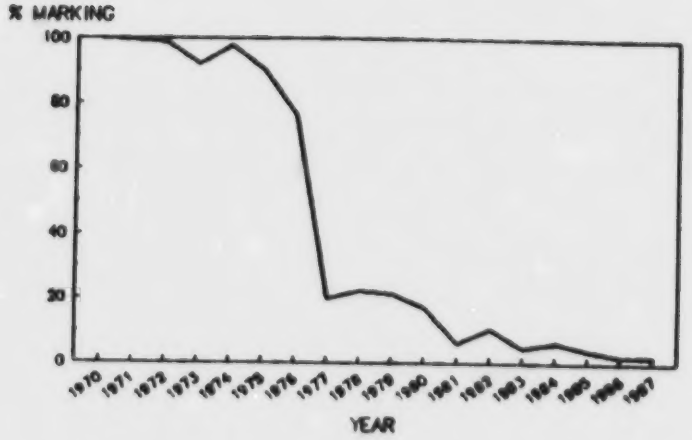

Figure 1: Lamprey marking rates for coho salmon sampled during the Credit River spawning assessment (1970-1987)

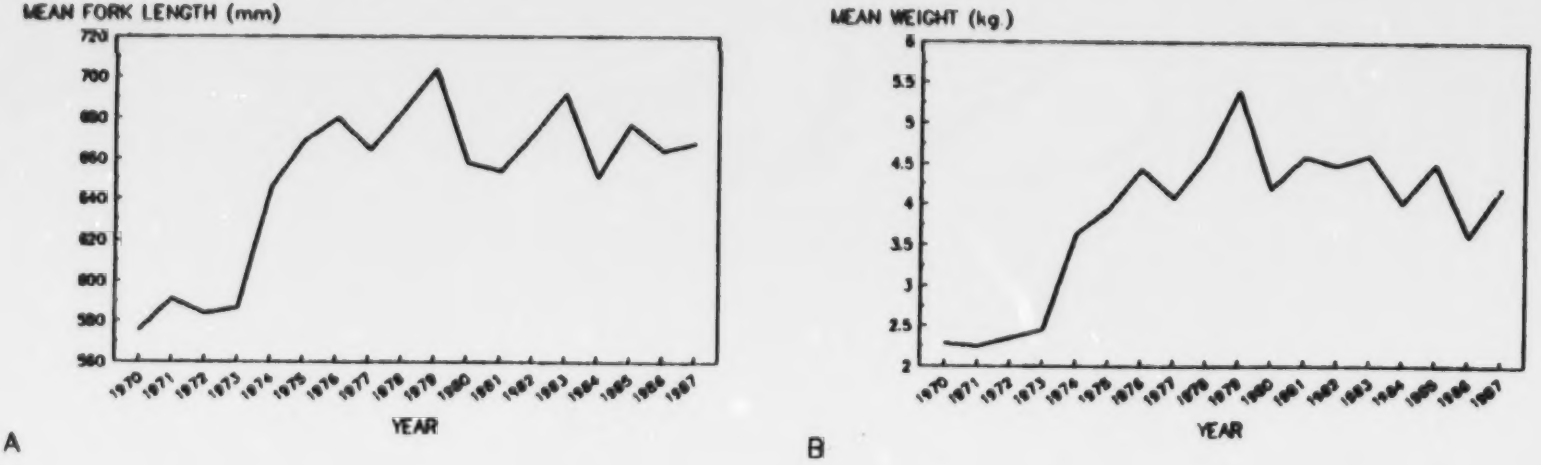

Figure 2: Fork length (A) and weight (B) of coho salmon sampled during the Credit River spawning assessment (1970-1987)

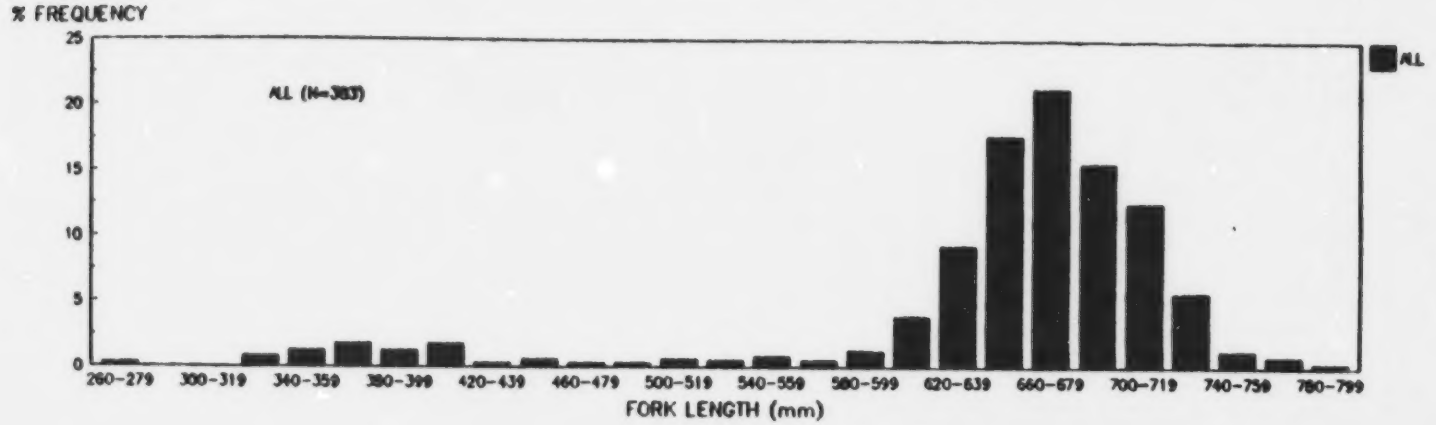

Figure 3: Length frequency distribution of all coho sampled during the 1987 Credit River spawning assessment

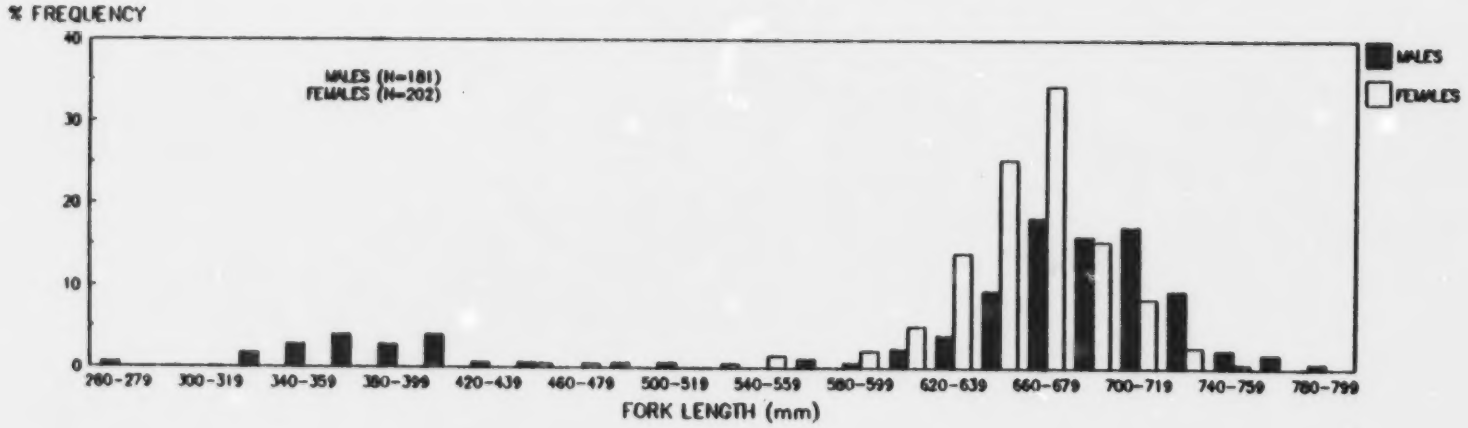

Figure 4: Length frequency distribution of male and female coho sampled during the 1987 Credit River spawning assessment

Great Lakes Fishery Commission
Lake Ontario Committee
March 8-9, 1988

WESTERN LAKE ONTARIO HARVEST ASSESSMENT, 1987

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ABSTRACT

The 1987 fishing activity in the western basin of Lake Ontario was monitored by means of trailer counts at all access points and access creel survey at 5 major access points. The survey covered the entire period from April 1 to September 30 and was stratified by month, day type (weekday, weekend day/ holiday), and time period. Total estimated fishing effort at individual access points ranged form 25,000 angler-hours at Whitby to 42,000 angler-hours at Port Dalhousie. Most anglers (78 %) were local, travelling less than 25 miles to fish and the majority (55 %) fished Lake Ontario almost exclusively (75-100 % of their annual fishing trips). Angler experience varied with the most common (39 %) level of experience being 2 to 4 years. Based on trailer counts, spring activity was concentrated on the south shore, while mid-summer and fall activity was more evenly distributed with Toronto area access points and the Port Credit area predominating. The total estimated effort in 1987 was 628,000 angler-hours resulting in a harvest of 61,807 salmonids weighing 283,737 kg. Chinook salmon was the dominant species by number (65.3%), followed by rainbow trout (20.9%), coho salmon (7.9%), lake trout (4.2%), brown trout (1.2%), and atlantic salmon (<1%). Although the results were confounded with a high proportion of unclipped stocked fish, 15% , 28%, and 21% of harvested coho salmon, rainbow trout and brown trout, respectively, were of American origin. Lamprey marking rates were 1.72, 0.51, 1.18, 4.87. and 45.56 % for chinook salmon, coho salmon, rainbow trout, brown trout, and lake trout respectively. Total basin effort decline slightly in 1987, while harvest declined by 28%. For the first time since 1980 observed salmonid CUE declined. Further analysis revealed that this was not due to changes in sampling design, but the reasons for the decline are unknown.

RECOMMENDATIONS

1) Continue to seek improvement to the overall creel design, particularly by direct survey of charter boat, moored boat, and shore angler fishing effort and harvest.

2) Insure that any design changes allow for assessment of year to year changes in effort, catch, harvest and CUE.

3) Explore further possible explanations for the observed reduction in salmonid CUE in 1987.

4) Include in all future surveys the assessment of angler experience, recording of fin clip information, lamprey wound monitoring and lake trout coded wire tag collection.

5) Derive new length/weight curves for principal salmonids in 1988.

6) Lobby for increased fin clipping of stocked rainbow trout and brown trout, particularly American steelheads.

7) Investigate the feasibility of implementing a cooperative angler program to obtain biological information of angler catch, as well as harvest and CUE.

8) Investigate alternatives to fin clips for recognizing rainbow trout and brown trout of hatchery origin.

INTRODUCTION

The salmonid fishery in the western basin of Lake Ontario has grown tremendously in the last decade making monitoring and assessment an increasingly expensive and difficult task. The fishery is largely driven by fishing derbies. In 1978 the only major derby was the Toronto Star Great Salmon Hunt concentrated near Toronto in the late summer and fall. In 1987 there were 6 derbies in operation which collectively resulted in derby activity from April to September. Early assessments concentrated on monitoring the individual derbies. Full basin wide surveys were not completed until 1985 (Daniels and Savoie, 1986). The 1987 survey was the first to sample the complete fishing season and provide for stratification of the survey results by month independent of derby activity.

The survey results apply only to anglers that launch their boats daily at public access points. The charter boat effort and harvest is estimated through mail surveys (Stewart 1988) and the magnitude of moored boat and shore angler effort and harvest remains unknown. The following report details the results of the 1987 survey and examines recent trends in the fishery.

METHODS

CREEL SURVEY DESIGN

The creel survey design was based on access point surveys of anglers that launch their boats daily from 5 major sites stratified by month (April-September), time period (3-3 hour strata) and day type (weekdays and weekends or holidays). Survey results were expanded to estimated catch, effort and harvest for the entire Western Basin (Cobourg to Niagara) of Lake Ontario based on counts of boat trailers at all access points stratified by month. In addition, corrections were applied to account for fishermen returning to the access point after 2000 hours, and estimates of the proportion of trailers counted that were used for non-fishing boats.

SELECTION OF CREEL SITES

The creel sites were selected based on previous survey results to attempt to survey the most active sites while maintaining a broad geographic representation. The access points selected were Port Dalhousie (St. Catharines), Fifty Mile Point (Grimsby area), Port Credit, Bluffer's Park (Scarborough), and Whitby (Figure 1).

SEASONS

The survey period extended from April 1 to September 30, 1987. Each access point was surveyed for 3-4 weekdays and 3-4 weekend/holidays per month. Survey days were distributed throughout the week avoiding obvious biases and taking into consideration the number of surveyors and travel time between sites.

DAY TYPES

The survey was stratified by weekday and weekend/holidays. Weekend/holidays included all weekend days and all statutory holidays. Fishing effort is higher on weekend/holidays and therefore an attempt was made to survey as many of these days as was logistically possible with the remaining time spent on weekday surveys.

TIME PERIODS

Three time periods were selected; 1100-1400 hours, 1400-1700 hours, and 1700-2000 hours, based on previous surveys that showed that few anglers return to the access points outside of these times.

INTERVIEWS AND ACTIVITY COUNTS

Detailed instruction for the 1987 creel survey technicians are on file at the Ontario Ministry of Natural Resources, Central Region, Richmond Hill. Counts of the number of boats removed from the water at boat ramps during each hour of the survey day were used to estimate daily activity at each access point. An attempt was made to interview as many boat parties as possible while not compromising the activity counts. The interviews provided estimates of the length of the trip, number of anglers, species caught and released, angler characteristics, and biological information for harvested fish. Angler characteristics

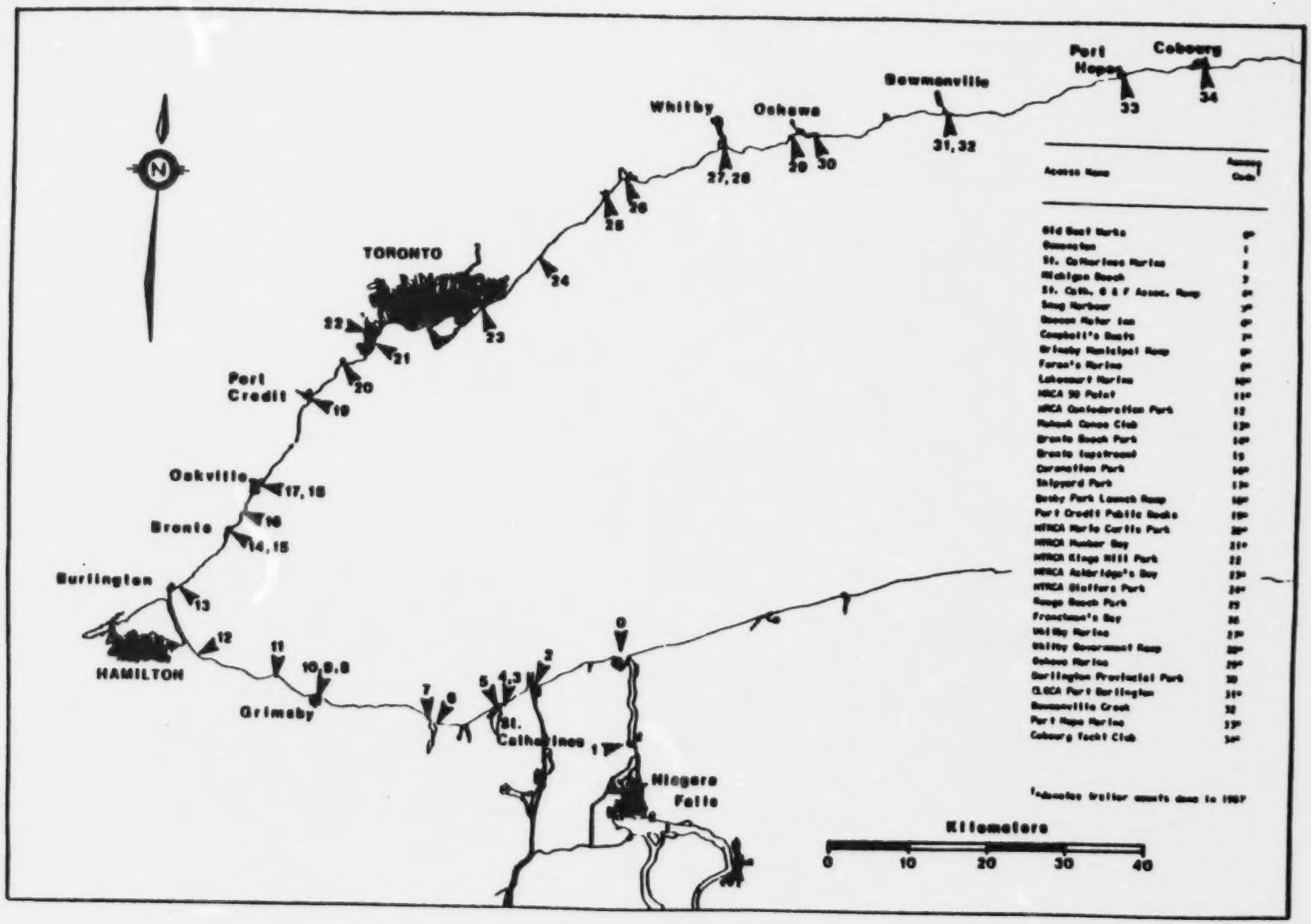


Figure 1: Public access points for boats in Western Lake Ontario

surveyed included the distance travelled to fish Lake Ontario, the importance of the Lake Ontario fishery in relation to other fisheries, and the experience of the angling party.

ANALYSIS

The analysis of the access point surveys was done using CREESYS (Lester and Trippel, 1985) providing estimates of angler effort, species catch, and harvest for each surveyed access point.

CREEL SURVEY PRORATIONS

TRAILERS COUNTS

Of the 34 access points surveyed in 1985 (Daniels and Savoie, 1986) 10 sites were excluded from future surveys as relative activity was generally below 1% of the total fishing activity. Since that initial survey an additional site (Old Boat Works, Niagara-on-the Lake) has been added giving a total of 25 access points (Figure 1). Trailers counts were done at each site each weekend, alternating systematically between Saturday and Sunday. Two major routes were required to complete the counts (north and south) and starting locations were varied to reduce bias due to the time of day the count was completed.

FISHING BOATS TO NON-FISHING BOATS

Included with the hourly activity count was the observed number of non-fishing boats using the trailer ramp. Daily counts of both the number of fishing boats and non-fishing boats were determined and monthly totals used to calculate the percentage of total trailers used by fishing boats only, for each of the five surveyed access points. Mean monthly percentages of fishing trailers was determined by averaging across all surveyed access points.

MISSED FISHING ACTIVITY

An estimate of the number of fishing parties that did not trailer their boats by the end of the fishing day was determined by counting the number of trailers remaining in the parking lot at 2000 hours. These numbers were used to derive a monthly estimate of the percent of activity missed by ending the access points surveys at 2000 hours.

PRORATION CALCULATIONS

The trailers counts were used to determine the relative activity across access points. To correct for non-fishing boat trailers the monthly trailers counts at each of the five surveyed access points were multiplied by the monthly estimates of the percentage of fishing trailers determined for each site. At all other sites the trailer counts were multiplied by the mean monthly percentage of fishing trailers observed at creel sites. From these data the proportion of total fishing activity occurring at each access point each month was determined. An expansion factor was calculated for each month based on the proportion of the total activity represented by the surveyed access points.

Monthly sums of the number of trailers remaining after 2000 hours were compared to the total monthly fishing boat effort for all surveyed

access points combined. From these data a second monthly expansion factor was calculated to account for the proportion of fishing activity missed each month.

The two expansion factors were combined to derive a single expansion factor for each month. Monthly estimates of effort, catch, and harvest determined from the access creel surveys were multiplied by the monthly expansion factors. Variance estimation assumed that the expansion factors were measured without error, therefore variances are underestimated.

BIOLOGICAL SAMPLING

From a sub-sample of fishing boats, each fish landed was identified and the fork length measured. Fin clips were recorded and if the fin was more than 50 % regenerated the degree of fin regeneration was classified into three broad categories; 50-74%, 75-90%, and 90+ %. Fish with lamprey marks were also measured for total length, and the type, stage and diameters of marks recorded (King and Edsall, 1979). Attached lamprey were counted and measured for length. The depth of water over which lamprey marked fish were caught was also recorded.

RESULTS

ACCESS SURVEYS

Sampling intensity was similar at each of the surveyed access points (Table 1). Most of the anglers interviewed (52 - 73 %) were participants in at least one of the six fishing derbies occurring during the survey period. Fishing effort ranged from 25,000 angler-hours at Whitby to 42,000 angler-hours at Port Dalhousie. The number of anglers per boat, and mean trip length varied little between access point. The number of boat trips ranged from approximately 2500 at Whitby to 5500 at both Port Credit and Bluffer's Park corresponding to a range of between 5,300 and 12,000 angler trips per access point. The estimated catch of salmonids ranged from approximately 4,000 at Fifty-Mile Point to 16,500 at Bluffer's Park corresponding to a range in harvest of between 2000 and 8500 salmonids. From 44 to 66 percent of the salmonids caught were released, lake trout were released at a rate of between 58 and 89 percent. Observed catch per unit effort (CUE) varied from 0.122 (8.2 hours/salmonid) at Fifty Mile Point to 0.233 (4.3 hours/salmonid) at Bluffer's Park.

ANGLER CHARACTERISTICS

Most anglers (78 %) were local, travelling less than 25 miles to fish and the majority (55 %) indicated that 75-100 % of their fishing trips were on Lake Ontario (Table 2). Angler experience varied; the most common (39 %) level of experience was 2 to 4 years.

Table 1: Summary of the 1987 salmonid fishery in Western Lake Ontario by surveyed access point

STATISTIC	SITE				
	Port Dalhousie	Fifty Mile Point	Port Credit	Bluffer's Park	Whitby
# interviews	1,008	892	1,382	1,293	634
Total # of 3-hr. strata sampled	126	120	129	122	117
% parties registered in a derby	72.9	52.2	63.1	76.0	68.0
Mean # boats counted/hr.	3.1	2.6	4.0	4.4	1.9
Mean # boats/3-hr. stratum	9.3	7.9	12.1	13.4	5.6
Total estimated effort (angler-hrs.) [SE]	42,004 [4,267]	31,949 [2,679]	64,498 [7,169]	65,720 [4,731]	25,009 [1,370]
Mean # anglers/boat	2.2	2.3	2.2	2.2	2.1
Mean trip length (hrs.)	5.1	4.6	5.4	5.5	4.7
Estimated # boat trips	3,697	3,083	5,491	5,501	2,538
Estimated # angler trips	8,244	6,968	11,971	11,993	5,304
Estimated catch of salmonids (# fish) [SE]	9,174 [796]	3,955 [241]	8,693 [619]	16,561 [1,074]	5,675 [376]
Estimated harvest of salmonids (# fish) [SE]	3,145 [345]	2,216 [162]	5,008 [418]	8,464 [634]	2,986 [235]
% released (all salmonids)	66.2	44.4	44.1	47.2	47.2
% lake trout released	89.1	58.1	74.9	75.4	67.2
Catch of salmonids/angler-hr. (observed)	0.214	0.122	0.134	0.233	0.227
# hrs. to catch a salmonid	4.7	8.2	7.5	4.3	4.4

TABLE 2: Summary of responses characterizing anglers in the 1987 creel survey.

a) **Distance travelled to fish Lake Ontario**

Category (miles)	0-10	11-25	26-50	51-100	>100
%	52.7	25.6	11.7	6.8	3.2

b) **Percent of annual fishing trips fishing salmon and trout on Lake Ontario**

Category	<25%	25-49%	50-74%	75-100%
%	15.7	8.2	21.4	54.7

c) **Number of years fishing salmon and trout in Lake Ontario**

Category (years)	1	2-4	5-7	8-10	>10
%	13.2	39.1	19.5	13.1	15.2

EXPANSION OF ACCESS POINT SURVEYS TO THE ENTIRE WESTERN BASIN

TRAILER COUNTS

The percent relative fishing activity at all access points based on the trailers counts and corrected for the proportion of non-fishing boats is shown in Table 3. Access point use varied over the season. Activity in spring was concentrated on the south shore, the most active sites being Port Dalhousie and Fifty Mile Point. During mid-summer and fall activity was more evenly distributed between access points but the Toronto area access points and Port Credit area predominated. The total relative percent activity represented by the surveyed access points ranged from 40.8 to 52.4 percent.

MISSED FISHING ACTIVITY

Based on trailers counts at surveyed sites after 2000 hours it was estimated that from 8.5 to 33.1 percent of the total fishing activity was missed by ending the access survey at 2000 hours (Table 4). The highest percent activity missed was estimated for June and July.

TABLE 3: Relative activity (%) during 1987 at all access points based on trailer counts corrected for the proportion of non-fishing boats. Surveyed access points are indicated by the asterisks. The total % relative activity surveyed is the sum of the % relative activity of surveyed access points.

Access Points	April	May	June	July	August	September
Old Boat Works	4.0	3.5	0.7	0.4	0.4	0.6
*Port Dalhousie	33.9	25.0	2.9	1.4	7.3	10.8
Snug Harbour	0.1	0.2	0.1	0.1	0.0	0.1
Beacon Motor Inn	0.9	0.2	0.1	0.0	0.0	0.0
Campbell's Boats	8.8	4.5	2.3	0.6	1.0	3.5
Grimsby Municipal Ramp	4.1	1.6	0.9	0.7	0.1	0.2
Foran's Marine	2.7	2.9	1.2	1.1	1.0	0.8
Lakecourt Marina	2.9	1.9	1.2	0.8	0.6	0.6
*HRCA 50 Point	16.4	18.5	1.3	0.4	3.0	4.4
HRCA Canoe Club	9.3	7.5	3.4	3.7	5.4	5.5
Bronte Beach Park	8.7	9.3	9.2	10.6	10.7	10.1
Coronation Park	0.6	0.6	1.4	1.9	1.5	0.9
Oakville (downstream)	0.0	1.4	3.0	2.7	3.5	2.1
Oakville (upstream)	2.2	2.6	2.5	1.9	2.7	2.0
*Port Credit Public Docks	2.1	0.6	5.4	10.4	14.7	26.3
MTRCA Marie Curtis Park	0.6	2.7	4.0	4.2	6.7	7.0
MTRCA Humber Bay	0.9	9.3	8.4	10.7	11.6	10.5
MTRCA Ashbridges Bay	0.2	2.4	6.1	7.2	4.5	1.5
*MTRCA Bluffer's Park	0.0	0.0	26.9	23.0	14.7	4.5
Whitby Marina	0.1	0.2	0.4	0.1	0.5	0.4
*Whitby Government Ramp	0.0	0.5	7.0	5.7	3.1	2.9
Oshawa Marina	0.1	0.5	2.1	2.6	1.2	1.2
CLOCA Port Darlington	0.5	2.0	6.1	5.7	3.5	2.0
Port Hope	0.4	1.2	2.0	3.1	1.7	1.4
Cobourg	0.5	0.7	1.5	1.3	0.6	0.6
Total % Relative Activity Surveyed	52.4	44.6	43.5	40.8	42.8	48.9

TABLE 4: Monthly expansion factors used to prorate 1987 access surveys to the entire western basin.

Month	% Relative* Activity Surveyed	Exp. Factor	% Missed Activity	Exp. Factor	Total Exp. Factor
April	52.4	1.91	8.5	1.09	2.08
May	44.6	2.24	16.7	1.17	2.62
June	43.5	2.30	33.1	1.33	3.06
July	40.8	2.45	29.4	1.29	3.16
August	42.8	2.34	14.3	1.14	2.67
September	48.9	2.05	9.2	1.09	2.23

* from Table 3

EXPANSION FACTORS

The expansion factors used to prorate the access surveys to the entire western basin were derived by multiplying the reciprocals of the proportions of both the total relative activity surveyed and the missed fishing activity (Table 4). The monthly expansion factors ranged from 2.08 to 3.16.

BASIN WIDE STATISTICS BY MONTH

Application of the expansion factors to the total monthly estimates of all surveyed access points combined allowed for estimates of total basin activity by month (Table 5). Monthly fishing effort ranged from 35,500 angler-hours in April to 191,500 in July. The total estimated effort for the season was 628,000 angler-hours. This corresponds to a monthly salmonid catch of between 3,000 to 51,000 fish for at total estimated catch of 125,500 salmonids. The harvest ranged from 1,800 to 15,500 salmonids per month for a total harvest of 62,000 fish.

Approximately 50 % of all salmonids caught were released and from 54 to 89 % of all lake trout caught were released. The observed CUE ranged from a low of 0.09 (11.4 hours/fish) in April to a high of 0.26 (3.8 hours/fish) in July. The overall basin wide CUE was 0.19 (5.4 hours/fish).

Table 5: Summary of the 1987 salmonid fishery in Western Lake Ontario by month.

STATISTIC	April	May	June	July	August	September	Total
# interviews	459	804	816	1,204	1,316	690	5,289
Total # of 3-hr. strata sampled	102	114	102	98	105	93	614
% parties registered in one or more derbies	44.2	55.9	72.4	78.3	85.4	32.6	67.0
Mean # boats counted/hr.	1.7	2.5	2.9	4.8	4.8	2.7	3.2
Mean # boats/3-hr. stratum	5.2	7.5	8.7	14.6	14.3	8.2	9.7
Total estimated effort (angler-hrs.)	35,478	71,300	95,429	191,645	159,619	74,533	628,005
[SE]	[5,757]	[9,078]	[5,897]	[13,409]	[10,414]	[14,887]	[25,695]
Mean # anglers/boat	2.4	2.2	2.1	2.2	2.2	2.1	2.2
Mean trip length (hrs.)	4.6	4.7	4.9	5.5	5.4	5.3	5.1
Estimated # boat trips	3,298	6,865	9,078	16,059	13,485	6,662	55,447
Estimated # angler trips	7,750	15,309	19,427	35,009	29,532	14,190	121,217
Estimated catch of salmonids (# fish)	3,131	11,836	19,116	50,733	33,226	7,443	125,478
[SE]	[380]	[1,745]	[1,375]	[3,178]	[1,833]	[1,032]	[4,428]
Estimated harvest of salmonids (# fish)	1,820	5,971	9,633	24,419	15,454	4,520	61,807
[SE]	[260]	[804]	[704]	[1,896]	[1,030]	[733]	[2,530]
% released (all salmonids)	42.5	48.2	51.3	54.0	52.0	39.6	50.8
% lake trout released	67.0	54.2	81.5	85.2	83.1	88.9	76.8
Catch of salmonids/angler-hr. (observed)	0.09	0.15	0.20	0.26	0.19	0.11	0.19
# hrs. to catch a salmonid	11.4	6.6	5.0	3.8	5.2	9.4	5.4

TABLE 6: Mean fork length and weight of 1987 harvested salmonids (N= sample size, standard errors are in brackets, weights were determined from length using length-weight curves reported in Daniels and Savoie, 1987).

Species	N	Mean Length (cm)	Mean Weight (kg)
Coho	293	55.8 [0.42]	2.82 [0.060]
Chinook	2,377	66.8 [0.41]	5.34 [0.082]
Rainbow trout	936	62.9 [0.33]	3.32 [0.042]
Brown trout	82	49.7 [1.24]	2.36 [0.179]
Lake trout	248	64.6 [0.58]	3.84 [0.105]
Atlantic salmon	13	59.2 [3.73]	-

TABLE 7: Summary of harvest by species for 1987 western Lake Ontario (standard errors of estimates are in Brackets).

Species	Average Wt. (kg)	Estimated Harvest (#'s Fish)	% Total Harvest	Estimated Harvest (Wt. in kg)	% Total Harvest
Coho	2.82 (0.060)	4,875 (368)	7.9	13,748	4.8
Chinook	5.34 (0.082)	40,366 (2,363)	65.3	215,554	76.0
Rainbow trout	3.32 (0.042)	12,928 (783)	20.9	42,921	15.1
Brown trout	2.36 (0.179)	721 (110)	1.2	1,702	0.6
Lake trout	3.83 (0.105)	2,567 (229)	4.2	9,832	3.5
Atlantic salmon	-	152 (32)	0.3	-	-
Unknown salmonid	-	198 (65)	0.3	-	-
Total		61,807		283,757	

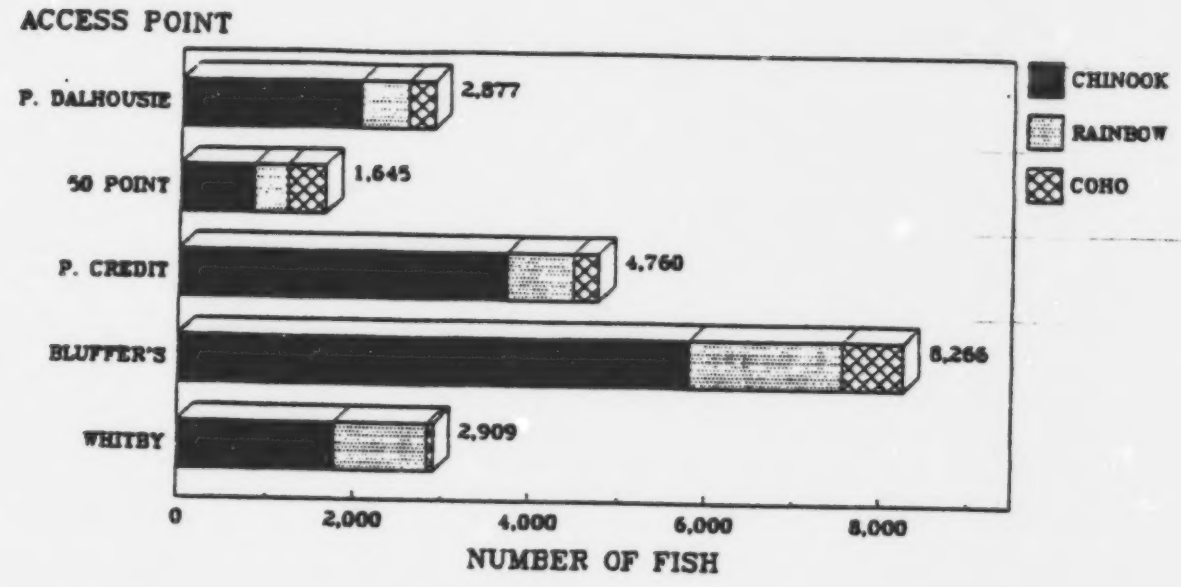
The estimated harvest of each species was multiplied by the the mean weight (Table 6) to derive estimates of the total harvest by weight for each species (Table 7). The total harvest of salmonids in 1987 was estimated at 61,807 fish corresponding to a weight of 283,757 kg. Chinook salmon was the dominant species in the harvest (65.3 %). Rainbow trout comprised 20.9 % of the harvest and coho salmon 7.9 %. Lake trout and brown trout comprised 4.2 and 1.2 % of the harvest, respectively. The harvest of Atlantic salmon was less than 1 % of the total salmonid harvest. The species composition of the harvest expressed as weight followed the same pattern with chinook comprising 76 % of the total salmonid harvest by weight.

Species composition varied between access points most likely due to seasonal variation in the distribution of effort and species catchability. Fishing derby rules also influence the species composition of the harvest. The harvest of coho salmon, chinook salmon, Atlantic salmon, and rainbow trout was highest at Bluffer's Park (Figure 2a, 2b). Higher harvests of lake trout and brown trout at Port Dalhousie and Fifty Mile Point (Figure 2b) may have resulted from the concentration of effort in spring at these sites and because area derbies (St. Catharines Game and Fish Association Salmon Derby, International Lake Ontario Fishing Classic) included lake trout as eligible entries. Chinook harvest may have been reduced at these sites due to a 20 pound minimum weight for chinook salmon entered in the St. Catharines derby. Atlantic salmon are low in abundance and are not consider eligible as derby entrants and thus remain a minor component of the salmonid harvest.

BIOLOGICAL CHARACTERISTICS OF HARVESTED FISH

Table 6 summarizes length and weight statistics for harvested salmonids. Sample sizes were adequate for all but Atlantic salmon. Length and weight statistics are strongly influenced by derby regulations. All 1987 derbies had an 8 pound limit for fish entered in the derbies , while the St. Catharines derby had a 20 pound limit for chinook salmon. Fin clips were recorded for all sampled fish. Interpretation of these data is difficult due to the stocking of a high proportion of unclipped salmonids by both Canadian and American agencies. Seventy-five percent of coho harvested where unclipped reflecting the high proportion of unclipped coho stocked into Lake Ontario, primarily by American agencies. Of the remaining 25 % of the coho 15 and 7 % could be classified as originating from Canadian or American stocking programs, respectively (Table 8). For rainbow trout, 66 % of the harvested fish were unclipped. Approximately 28 % of the rainbow trout harvest was of American origin, while only 2-4 % of the harvest could be confidently classified as Canadian. fish of hatchery origin comprised 66 % of the brown trout harvest, of which 21 % was American, and from 16 to 41 % were Canadian.

All lake trout with an adipose clip are marked with coded wire tags. Of 240 lake trout sampled 64 (27 %) had an adipose clip suggesting that creel samples may be a valuable source of lake trout coded wire tag returns.



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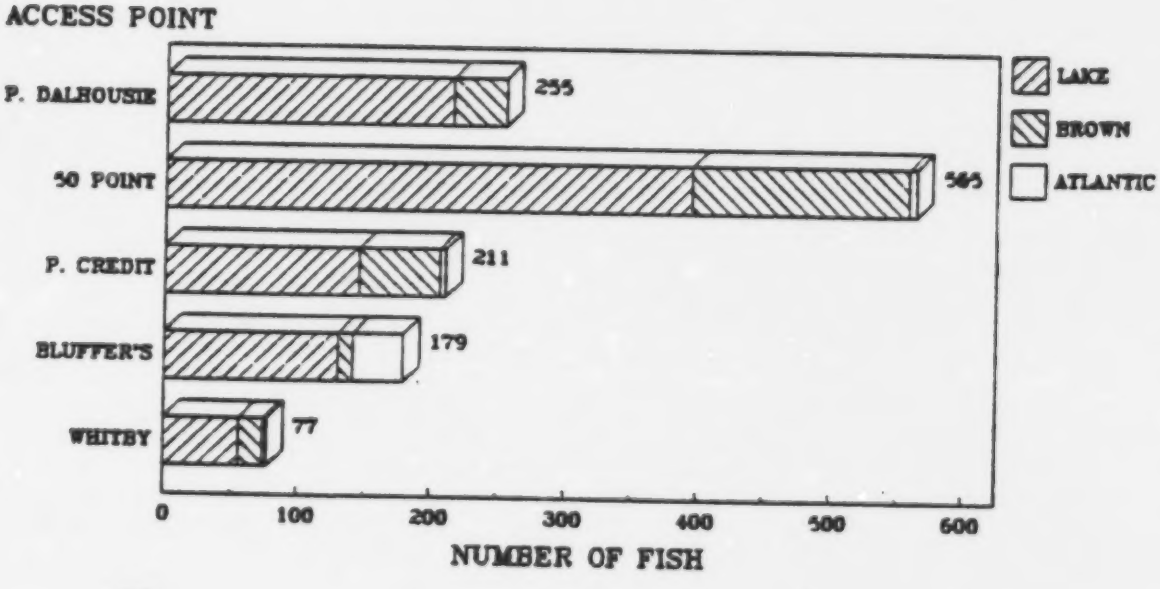

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NOTE: X-axes are different scales.

FIGURE 2: Species composition of the harvest by access point.

TABLE 8: Fin clip summary for selected salmonids from the Western Basin of Lake Ontario 1987. The numbers in brackets are the percent of the total sample.

	Coho		Rainbow Trout		Brown Trout	
American fish (left side fin clips and combinations)	28	(7.4)	249	(27.9)	17	(21.3)
Canadian fish (right side fin clips and combinations)	58	(15.3)	20	(2.2) (3.7)*	13	(16.3) (41.3)*
Total clipped (left or right only)	86		269		30	
Total not clipped	285	(75.0)	593	(66.4)	27	(33.8)
Other clips	9	(2.4)	31	(3.5) (2.0)*	23	(28.8) (3.8)*
Total sample	380		893		80	

* assumes adipose fin clips are Canadian fish

The creel survey provided information on lamprey marking for all salmonids (Appendix I). Marking rates were 1.72, 0.51, 1.18, 4.87, and 45.56 percent for chinook salmon, coho salmon, rainbow trout, brown trout, and lake trout, respectively (Table 9).

CREEL DESIGN

The current creel design is a compromise between statistical rigour and sampling cost. Estimates of effort, catch and harvest are limited to anglers that launch their boats daily from public access points. Variance components not accounted for in the determination of standard errors include those associated with the trailer counts and fishing to non-fishing boat ratios. The use of trailer counts to prorate the survey results assumes that the trailer counts (corrected for non-fishing boats) are linearly related to estimated effort. A regression of corrected

TABLE 9: Summary of the 1987 lamprey marking data.

	Chinook Salmon	Coho Salmon	Rainbow Trout	Brown Trout	Lake Trout
Total # marks	41	2	11	4	113
Total # marked fish	38	2	11	4	89
Marking rate [1]	1.72%	0.51%	1.18%	4.87%	45.56%
Incidence of attack[2]	1.60%	0.51%	1.18%	4.87%	35.89%
Total # wounds (AI-II)	23	1	1	3	23
Wounding rate	0.97%	0.25%	0.11%	3.85%	9.27%
Total # scars (AIII-IV, BI-IV)	18	1	10	1	90
Scarring rate	0.76%	0.25%	1.07%	1.22%	36.29%

[1] Marking rate = $\frac{\text{total \# marks observed}}{\text{total \# fish sampled}} \times 100$

[2] Incidence of attack = $\frac{\text{\# fish with 1 or more marks}}{\text{total \# fish sampled}} \times 100$

trailer counts against estimated effort (Figure 3) supports this assumption. Modifications of the current design should be implemented with caution to insure that changes in the fishery from year to year can be confidently assessed.

The current design requires the use of length/weight curves to determine individual harvest by weight. This is a good alternative to weighing large numbers of sampled fish, however the length/weight curves were determined from fish sampled in 1983-85, and more current weight data should be collected.

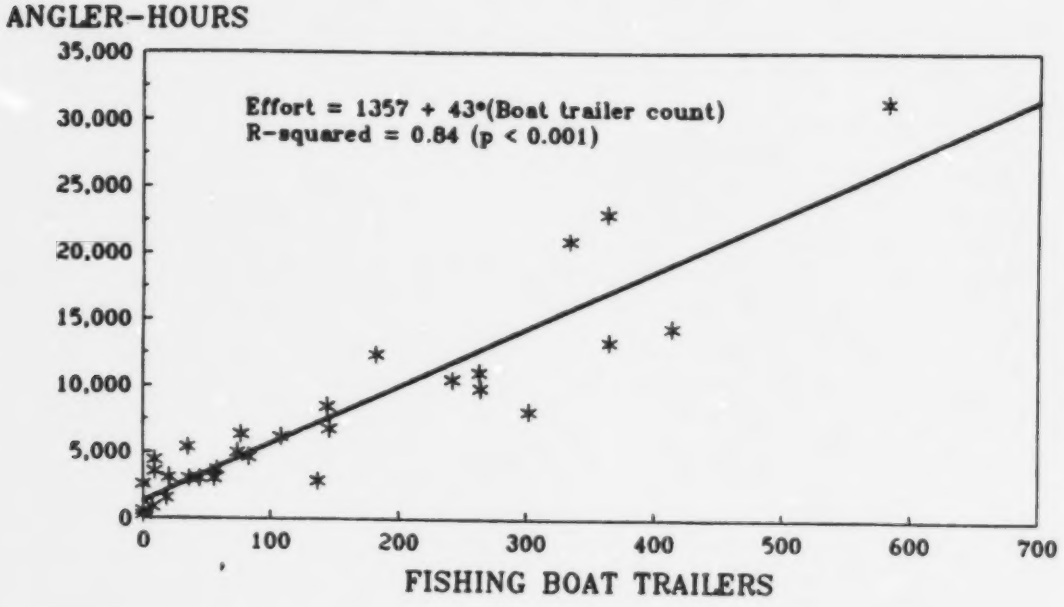

FIGURE 3: Relationship of fishing boat trailer counts to estimated fishing efforts.

RECENT TRENDS

Estimates of catch, effort and harvest for the entire western basin of Lake Ontario have been limited to the years 1985, 1986, 1987 and Daniels et al. (1985) determined preliminary estimates for 1984. However, the Toronto Star Great Salmon Hunt has been monitored almost continuously since 1977. As the fishery is largely dependent on stocking and derby activity, total basin activity closely matches trends in the Toronto Star Derby.

In 1987 it appears that total basin fishing effort did not increase (Figure 4) , and that harvest actually decreased (Figure 5). This change does not appear to be an anomaly. Re-analysis of the 1987 survey corresponding to dates and access points associated with the monitoring of the Toronto Star Derby in past years provided a basis for more in-depth comparison. Salmonid CUE observed during the derby decreased for the first year since 1980 (Figure 6).

In order to determine if the observed reduction in CUE was due to sampling error, site and season specific CUE's were compared between 1986 and 1987. Daniels and Kristmanson (1987) report observed salmonid CUE's at two week intervals over the period July 12 to September 7, 1986 at 5 access points common to the 1987 survey. Calculation of corresponding observed CUE's in 1987 revealed that CUE did decline in 1987 (Figure 7) and the difference was statistically significant ($p < .05$, paired Wilcoxon signed rank test, Sokal and Rohlf 1981).

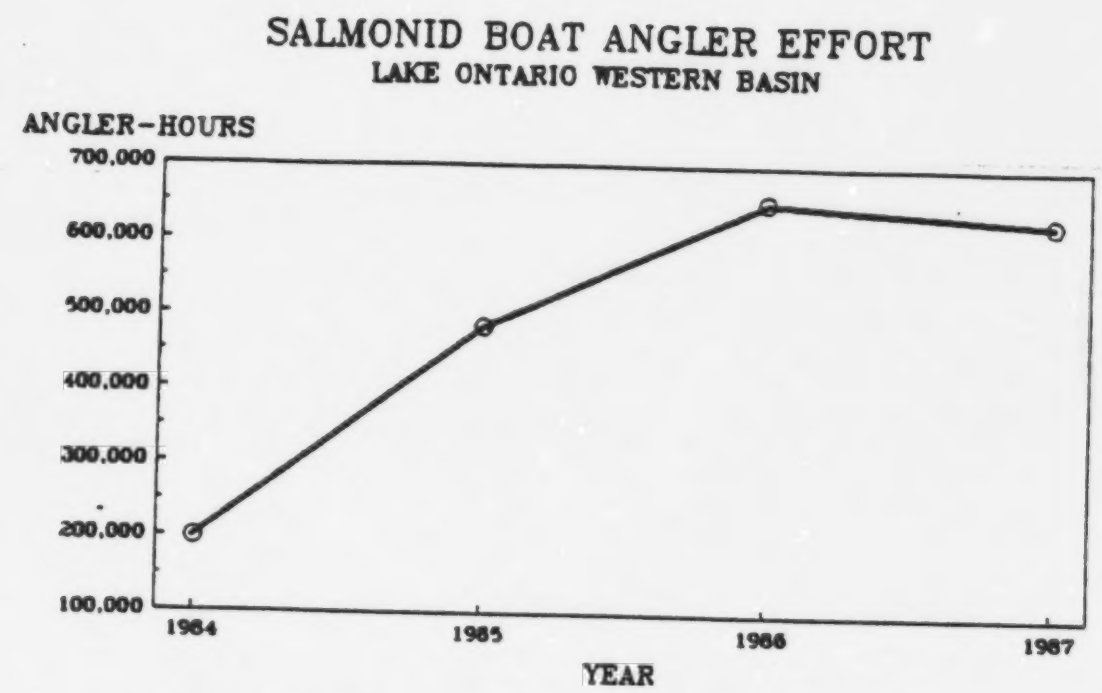

Figure 4: Trends in salmonid boat angler effort in the western basin of Lake Ontario

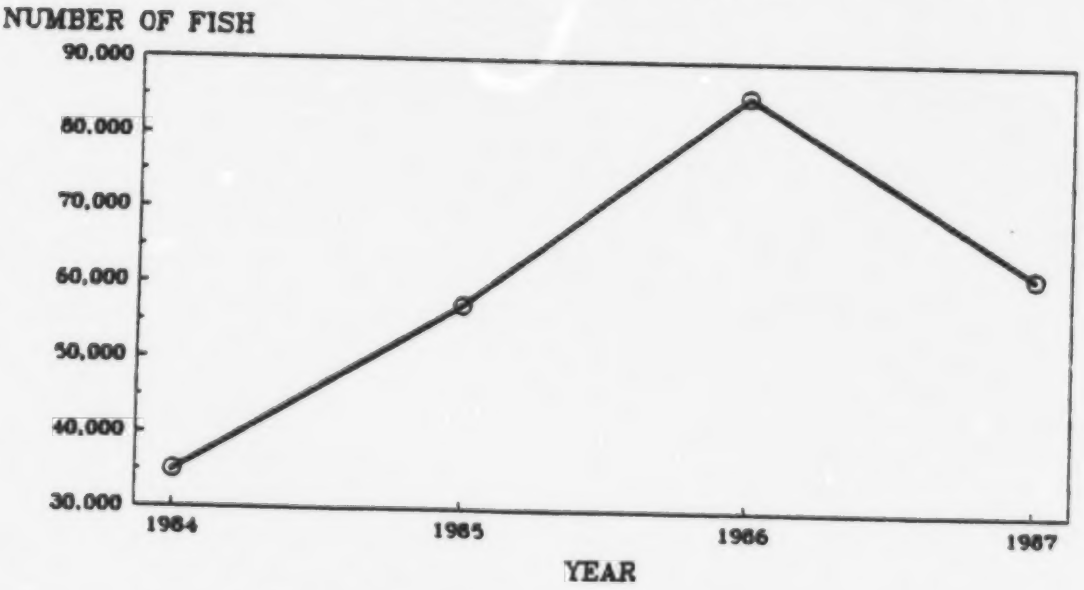

Figure 5: Trend in salmonid harvest in the western basin of Lake Ontario

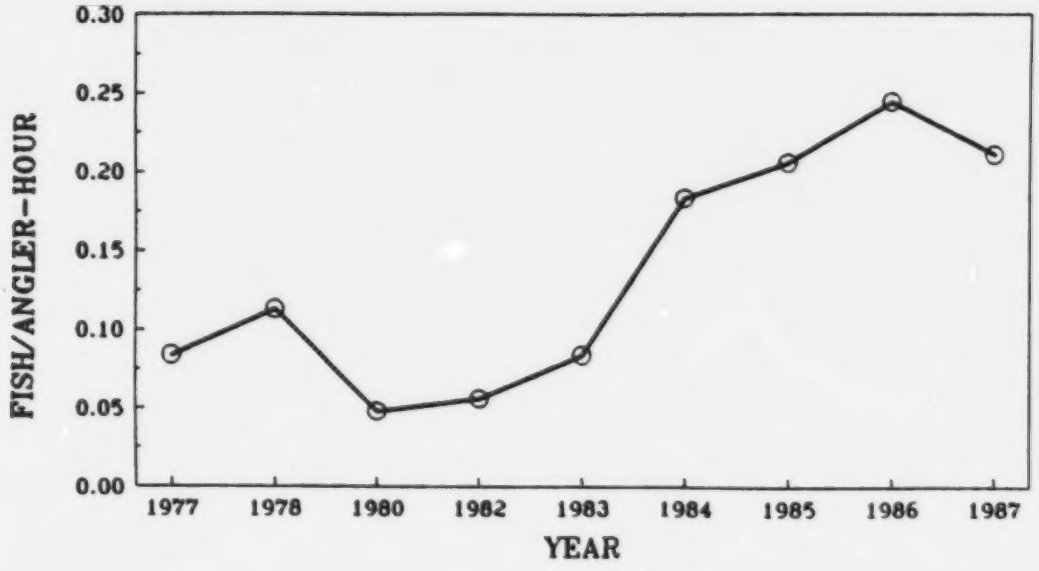

FIGURE 6: Trends in catch per unit effort (CUE) during the Toronto Star Derby.

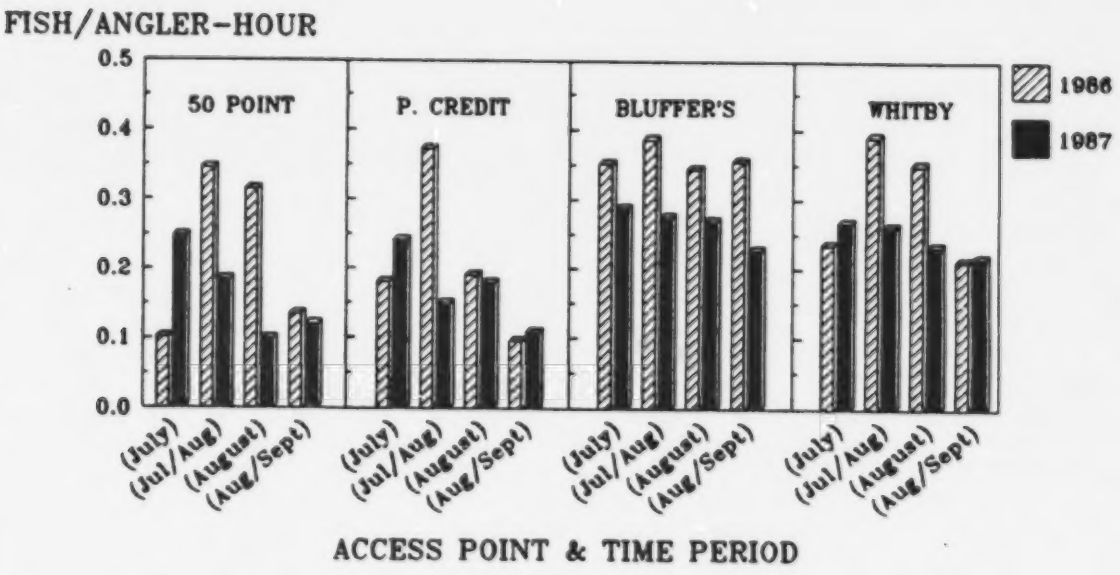

FIGURE 7: Comparison of catch per unit effort (CUE) at selected access points and time periods corresponding to the Toronto Star Derby.

Determining the most likely explanation for the change in CUE will require further analysis. Potentially profitable lines of investigation would include comparison to American surveys, independent estimates of fish abundance or mortality, angler characteristics (amount of experience, derby participation) and weather.

Angler experience was recorded for the first time in 1987 (Table 2) and should be included in future surveys. The 1987 data should be stratified by angler experience and CUE compared among categories. Experienced anglers may prove to have higher and less variable CUE than other groups thus providing a valuable index of salmonid abundance and fishing quality.

Biological samples collected during the creel survey have inherent biases associated with derby eligible weights and angling selectivity. Samples of anglers catches as opposed to the current harvest sampling would be valuable in this regard. The only feasible way to obtain these samples would be from a cooperative angler program. Such a program could also provide independent estimates of CUE.

The creel survey has the potential to provide valuable stocking assessment information. Preliminary interpretations of the data suggest that a large proportion of the rainbow trout and brown trout caught in Canadian waters are American stocked fish. A closer look at the individual clips reveal that 86 % of the American caught rainbow are steelhead (migratory rainbow trout which undergo the parr-smolt transformation) rather than domestic stocks. However, interpretation of this data is limited by the high proportion of fish stocked without a clip. Both rainbow trout and brown trout reproduce naturally in Lake Ontario but we do not know to what degree naturally reproduced fish contribute to the fishery. Spawning habitat improvement and protection for these species is ongoing and natural reproduction could increase to the point where stocking could be severely reduced. It is impossible to assess the degree of natural reproduction without an increase in the marking of stocked fish. Alternatively, if stocked fish can be recognized from aberrant calcified structures (Casselman, 1988) and all Canadian stocked fish were marked the extent of natural reproduction could be estimated and the contribution of American and Canadian fish determined.

The biological sampling also provided data on lamprey marking. These data should be incorporated into other monitoring programs with appropriate spatial and temporal stratifications.

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ACKNOWLEDGMENTS

The survey was designed, implemented and directed by M. Daniels with the support of an enthusiastic field crew (J. Kristmanson, A. Sameic).

Table A1: Lamprey marking on chinook and coho salmon and brown, rainbow and lake trout observed during the 1987 creel survey

Type	Stage	Chinook Salmon		Coho Salmon		Lake Trout		Brown Trout		Rainbow Trout	
		# Marks	Mean Diameter (mm)	# Marks	Mean Diameter (mm)	# Marks	Mean Diameter (mm)	# Marks	Mean Diameter (mm)	# Marks	Mean Diameter (mm)
A	I	14	31	1	30	6	26	0	0	1	25
	II	9	34	0	0	17	27	3	33	0	0
	III	3	33	0	0	13	26	0	0	3	23
	IV	1	35	1	25	26	28	0	0	1	24
B	I	1	25	0	0	6	28	0	0	2	35
	II	4	36	0	0	8	24	0	0	1	20
	III	3	32	0	0	6	31	1	30	0	0
	IV	6	33	0	0	31	29	0	0	3	32

Great Lakes Fisheries Commission
Lake Ontario Committee Meeting
March 7-9, 1988

EASTERN LAKE ONTARIO SALMONID CREEL SURVEY, SUMMER 1987

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Lake Ontario Fisheries Unit
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ABSTRACT

Two distinct salmonid fisheries were identified in Eastern Lake Ontario. The most abundant species in the harvest in the Kingston Basin was lake trout (12,202 fish harvested) while in the Central Basin fishery it was chinook salmon (7,404 fish harvested). The numbers of fish harvested of other species were relatively small. We estimate that angler effort during our survey in the Kingston Basin was 40,221 rod hours, while it was 49,785 rod hours in the Central Basin.

RECOMMENDATIONS

1. If access points in the Central Basin remain limited, we recommend that the design of future creels for the Central Basin should be based on access creel surveys at the Wellington Government Dock and Brighton Marina, with trailer counts at any other access points.

2. Access creels should not be relied on to provide total harvest estimates in the Kingston Basin. Aerial boat counts combined with frequent on-water interviews would provide an optimal design. Charter boat operator surveys would provide a valuable index of catch and harvest rates in this area.

INTRODUCTION

The sports fishery for salmonids in the Eastern Lake Ontario is at an early stage of development and is growing rapidly. The development of this fishery has accompanied recent increases in stocking of salmonids into Lake Ontario by the Ontario and the United States governments. This report describes the 'frame study' we conducted during the summer of 1987. It provides estimates of the size of the current fishery and also provides information which may be useful for designing future surveys.

METHODS

The design of this survey contains several components some of which overlap with each other to allow crosschecking. The components of the survey include: creel surveys at four access points, aerial boat counts, charter boat operators' diary, and interviews conducted with anglers on the water. The information from the charter boat operator diaries will be summarized in a forthcoming report.

The survey was conducted from May 16, 1987 until September 18, 1987. Fishing pressure was measured using aerial boat counts. Two flights were conducted during each week - one on a week day and one on a weekend day (weekend days include holidays). The aerial survey covered Eastern Lake Ontario from the west end of Wolfe Island to Spencer Point near Colborne (Figure 1). Boats were counted and marked on maps, and the location was recorded using the five minute grid system. All aerial counts were conducted at the peak of angling activity (10:00 to 12:00) and were extrapolated to daily estimates of boat activity using the daily pattern of angler activity determined from the access creel surveys (Figure 2).

The access survey data were designed, entered and processed using the CREESYS software package (version 3.2; Lester and Trippel, 1985). Four access points were chosen (Figure 1) because of their proximity to the area being surveyed and past experience of their popularity with anglers (S. Welham, personal communication): (i) Kingston Olympic Harbour, (ii) Collin's Bay Government Dock, (iii) Wellington Government Dock, (iv) Brighton Marina. Daytypes were stratified into workdays and non-workdays and the time of day was stratified into AM (9:00 - 15:00) and PM (15:00 - 21:00) periods. The creel surveys were initially run and estimates generated for each access point (Appendices 1 to 4).

On-water interviews were conducted with anglers whenever possible. Anglers were asked where they started their trip in order to determine the relative popularity of the access points which we surveyed.

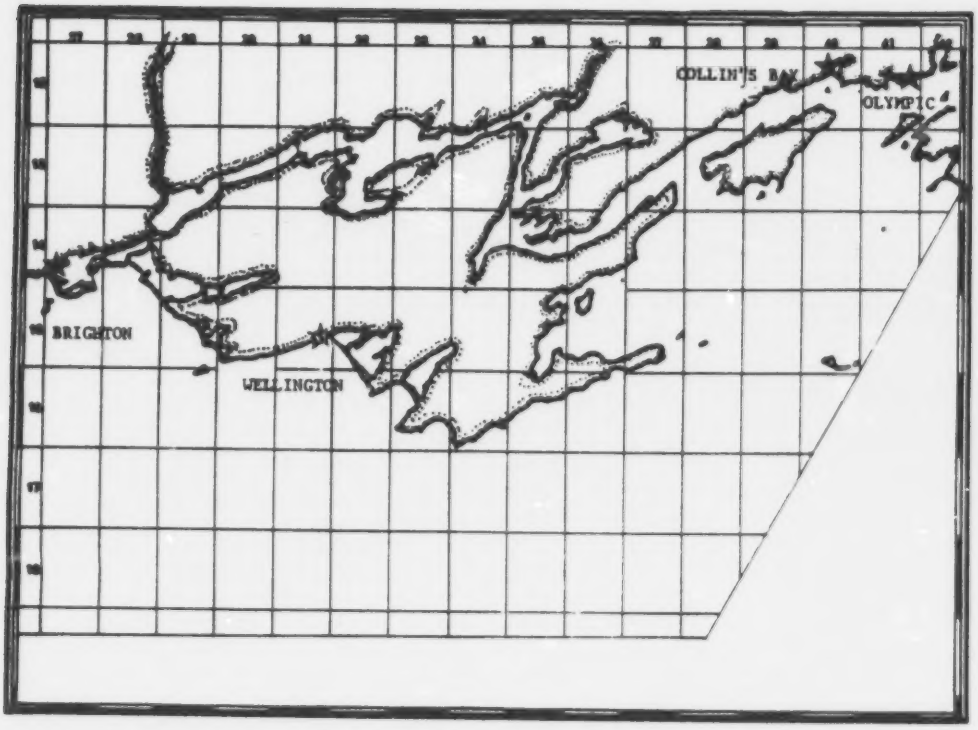

Figure 1. Eastern Lake Ontario including the areas used in the aerial survey and the four points where access surveys were conducted: Kingston Olympic Harbour (grid 1241), Collins' Bay Government Dock (grid 1240), Wellington Government Dock (grid 1531), and Brighton Marina (grid 1427).

ANALYSIS

A wide variety of fish species are caught by anglers in Lake Ontario near Kingston (Welham, 1985). Since the warmwater and coldwater fisheries may differ in their temporal and geographic patterns we sought to analyze the data from the coldwater fishery separately. To do this we isolated the fisheries on a geographic basis.

During the interviews conducted at the access points anglers were asked where they were fishing and these data were recorded using the five minute grid system. These data were used in conjunction with the other

information from the interviews to determine whether anglers were seeking warmwater species or coldwater species in each of the five minute grids (Table 1). Using these data the creel was subdivided into two geographic areas which are primarily coldwater fisheries - the Kingston Basin and the Central Basin (Figure 1).

Table 1: Designation of areas used in this survey. Included is a count from each of the areas of fishing parties interviewed which were fishing for warmwater and coldwater species. Warmwater anglers were defined a those seeking walleye, pike, smallmouth bass, largemouth bass, rock bass, or yellow perch. Coldwater anglers were defined a those seeking chinook salmon, lake trout, coho salmon, rainbow trout, lake whitefish, or lake herring.

AREA NAME	FIVE MINUTE GRID CODES	WARMWATER ANGLERS	COLDWATER ANGLERS
Kingston	1339 to 1342, 1437 to 1442, 1537 to 1541, 1637 to 1640, 1737 to 1739.	10	31
Central	1526 to 1529, 1626 to 1636, 1726 to 1736, 1531.	4	249
North Channel	1435, 1436, 1337, 1338, 1238 to 1241.	47	1
Pr. Edward Bay	1535, 1536.	0	0
Presquille Bay	1427.	9	0
Weller's Bay	1428, 1429.	6	0
Consecon Lake	1430.	0	0
Huycks' Bay	1530.	0	0
West Lake	1532.	0	0
East Lake	1533.	0	0

Catch per unit effort (CUE) and harvest per unit effort (HUE) data for the Kingston and Central Basins were extracted individually from the original access creel information. A total of 41 fishing parties interviews (114 anglers) collected at Portsmouth Olympic Harbour Site and Collin's Bay Government Dock

were used to estimate the CUE's and HUE's in the Kingston Basin fishery. A total of 255 fishing parties interviews (622 anglers) conducted at Brighton Marina and Wellington Government Dock were used to estimate the CUE's and HUE's in the Central Basin fishery. The harvest rates were combined with the effort data calculated with the aerial counts data to produce harvest estimates for the fisheries in these basins.

The aerial boat count information for the Kingston and Central Basins were analyzed individually. Boat counts from July 18 and August 16 in the Kingston and Central Basins were not used because the counters felt that the fog present on the water during those days caused them to underestimate the number of boats present. Boat counts from July 4 and 5 in the Kingston Basin were not used because there was a smallmouth bass derby that weekend and these samples would not have been generally representative of angler activity. The boat counts at the peak activity period were extrapolated to provide an estimate for the whole day using the temporal pattern of angler activity (Figure 2) derived from the access creel data. The mean number of rods per boat was also calculated from the access creel information and used in the estimation of the overall angler effort.

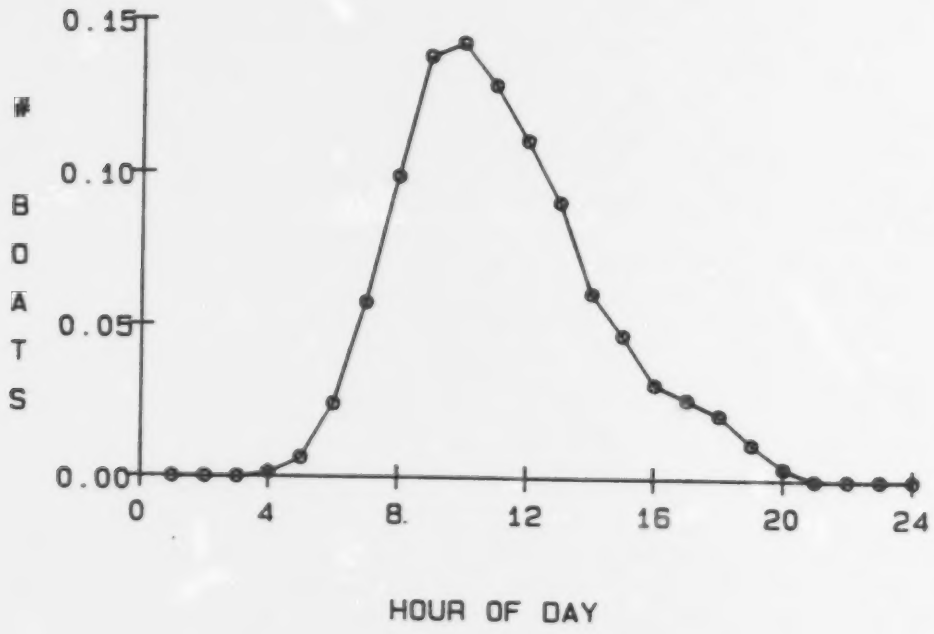

Figure 2: Daily temporal pattern of angler activity in the Kingston and Central Basins of Lake Ontario.

RESULTS AND DISCUSSION

Kingston Basin

The angler effort in the Kingston Basin was calculated to be 40,221 rod hours between May 16 and September 18, 1987. The seasonal pattern of angler activity during early May suggests that the coldwater fishery was already very active when our survey started (Figure 3). Charter boat operators' diaries indicate that the fishery was active from mid April. Angler activity had declined by the middle of September when our survey ended. There was also a peak in angler activity during early July. Forty-two on-water interviews suggest that only 40% of the anglers fishing in this area use the access points that we surveyed.

The harvest estimates (Table 2) suggest that the fishery in the Kingston Basin is based on Lake Trout. Lake Trout harvest (12,202 fish) was far larger than that of smallmouth bass (1,888 fish) and chinook salmon (571 fish).

Table 2. Summary of catch and harvest estimates (numbers of fish) for anglers fishing in the Kingston Basin and the Central Basin of Lake Ontario, May 16 to September 18, 1987.

SPECIES	KINGSTON BASIN		CENTRAL BASIN	
	CATCH	HARVEST	CATCH	HARVEST
Coho Salmon	0	0	93	103
Chinook Salmon	767	571	8504	7404
Rainbow Trout	0	0	1231	1100
Brown Trout	141	141	214	205
Lake Trout	14108	12202	410	308
Lake Whitefish	0	0	43	16
Lake Herring	83	71	0	0
Northern Pike	83	0	0	0
Rock Bass	226	0	0	0
Smallmouth Bass	5664	1888	0	0
Largemouth Bass	221	212	0	0
Yellow Perch	761	0	0	0

On-water interviews in this area during July suggest that a significant proportion of the anglers present in this area were residents of the United States fishing for smallmouth bass and that these same anglers were not using the access point that we were surveying. For this reason our access interview data under represents the importance of the smallmouth bass fishery in this area. This shortfall in our harvest rate information would lead to an overestimate of lake trout harvest and an underestimate of smallmouth bass harvest.

Of the 114 anglers interviewed who fished in the Kingston Basin forty-five percent were guided. Fourteen percent of the anglers were entered in

one of more fishing derby. Sixty-four percent of the anglers interviewed were from the Kingston area, while 33% were from other areas of Ontario, and 4% resided outside of Ontario.

The fork length distribution of the lake trout sampled by the creel survey crew in the Kingston is shown in Figure 4. The mean weight of the fish sampled was 2,791g.

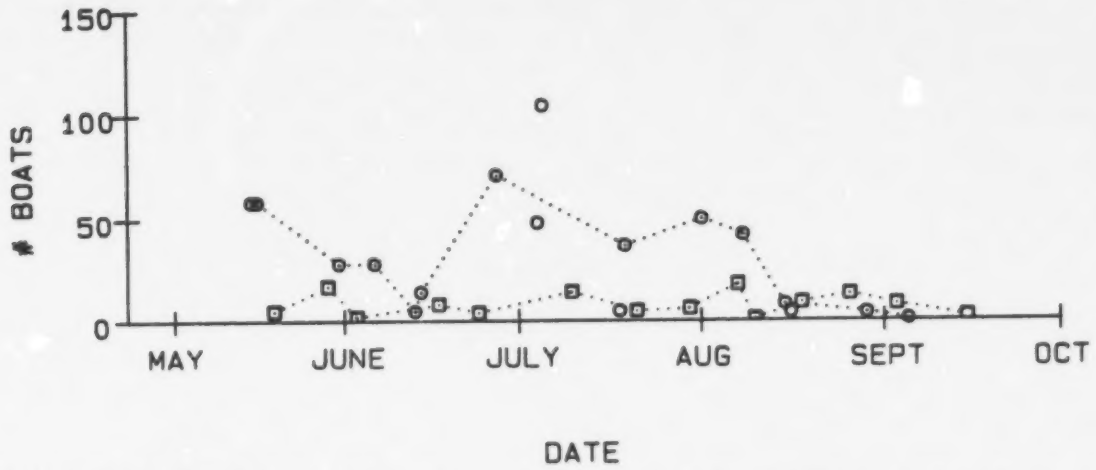

Figure 3. Seasonal temporal pattern of angler activity in the Kingston Basin of Lake Ontario. The data presented are boat counts for both weekends (circles) and weekdays (squares). Data points not joined by lines where excluded from the analysis because they were not representative due to fog or bass derbies.

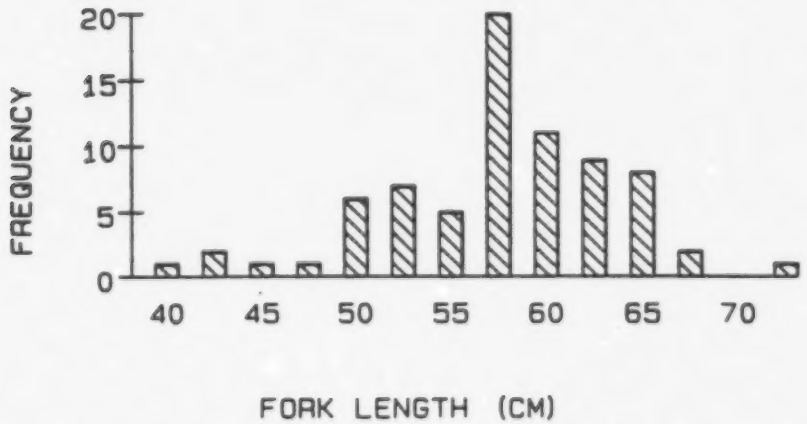

Figure 4: Fork length distribution of lake trout caught in the Kingston Basin of Lake Ontario and sampled by the access point creel survey crews.

Central Basin

Angler activity in the Central Basin appears to be very strongly concentrated between mid-June and mid-August (Figure 5). The estimate for our survey period was 49,785 rod hours. Fifty-five on-water interviews suggest that the fishery in the Central Basin was also concentrated in the sense that 84% of the anglers interviewed on the water used the launch ramps we were surveying.

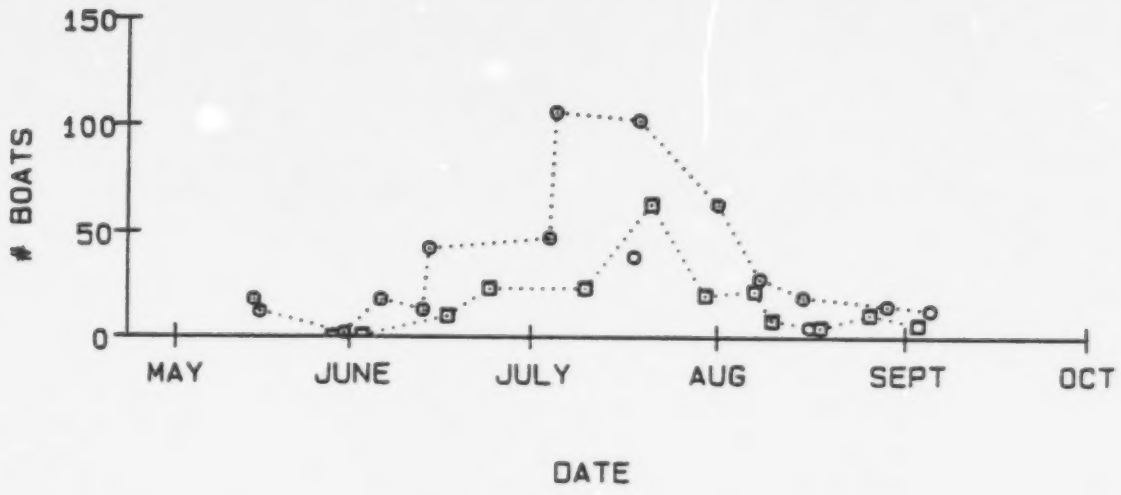

Figure 5. Seasonal temporal pattern of angler activity in the Central Basin of Lake Ontario. The data presented are boat counts for both weekends (circles) and weekdays (squares). Data points not joined by lines where excluded from the analysis because they were not representative due to fog.

The harvest estimates (Table 2) suggest that the fishery in the Central Basin is based almost entirely a chinook salmon. An estimated 6,959 chinook were harvested. Very few anglers sought other species and rainbow trout (1,100 fish) was the only other species caught in significant numbers.

Of the 622 anglers interviewed who fished in the Central Basin seventeen percent were guided. Sixty-eight percent of the anglers were entered in one of more fishing derby. Ninety-one percent of the anglers interviewed were local residents, while 8% were from other areas of Ontario, and 1% resided outside of Ontario.

The fork length distribution of the chinook salmon sampled by the creel survey crew in the Central Basin is shown in Figure 6. The mean weight of the chinook sampled was 6,233g and 2,830g for the rainbow trout sampled.

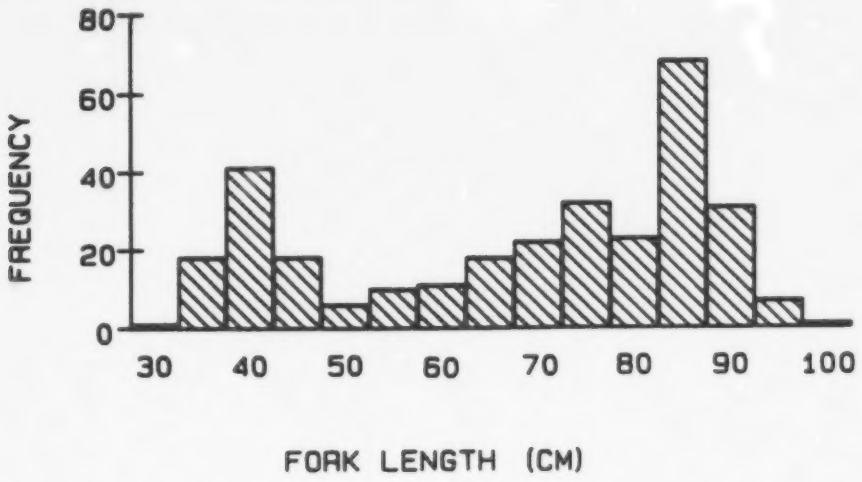

Figure 6: Fork length distribution of chinook salmon caught in the Central Basin of Lake Ontario and sampled by the access point creel survey crews.

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Appendix 1. Summary of catch, harvest and effort data from the creel survey conducted at Portsmouth Olympic Harbour Site May 28 to September 18, 1987. A total of 18 samples were taken, and 33 fishing parties were interviewed. Values in parentheses are standard errors.

ALL ANGLERS

Species	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	ESTIMATED Catch (#)	ESTIMATED Harvest (#)	ESTIMATED Effort (rd-hr)
Chinook	10	7	463	115 (85)	80 (52)	5776 (2121)
Brown Trout	0	0	463	0 (0)	0 (0)	5776 (2121)
Lake Trout	155	131	463	1870 (794)	1582 (679)	5776 (2121)
Lake Herring	1	1	463	12 (11)	12 (11)	5776 (2121)
Northern Pike	8	1	463	90 (68)	10 (9)	5776 (2121)
Smallmouth Bass	66	20	463	1246 (838)	358 (240)	5776 (2121)
Yellow Perch	75	0	463	875 (837)	0 (0)	5776 (2121)
Walleye	0	0	463	0 (0)	0 (0)	5776 (2121)

SPECIES SPECIFIC ANGLERS

Species	OBSERVED Anglers (#)	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	CUE (#/rd-hr)	HUE (#/rd-hr)
Chinook	13	1	1	58	0.173	0.173
Brown Trout	1	0	0	7	0.000	0.000
Lake Trout	72	155	131	391	0.396	0.335
Northern Pike	5	7	1	26	0.269	0.039
Smallmouth Bass	17	51	20	63	0.810	0.317
Walleye	6	0	0	27	0.000	0.000

Appendix 2. Summary of catch, harvest and effort data from the creel survey conducted at Collin's Bay Government Dock, May 28 to September 18, 1987. A total of 12 samples were taken, and 59 fishing parties were interviewed. Values in parentheses are standard errors.

ALL ANGLERS

Species	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	ESTIMATED Catch (#)	ESTIMATED Harvest (#)	ESTIMATED Effort (rd-hr)
Chinook	1	1	445	12 (12)	12 (12)	7252 (1753)
Brown Trout	2	2	445	23 (22)	23 (22)	7252 (1753)
Lake Trout	38	36	445	623 (284)	609 (279)	7252 (1753)
Northern Pike	13	6	445	199 (66)	89 (41)	7252 (1753)
Rock Bass	44	9	445	586 (466)	125 (98)	7252 (1753)
Smallmouth Bass	148	57	445	2437 (944)	943 (458)	7252 (1753)
Largemouth Bass	3	3	445	37 (35)	37 (358)	7252 (1753)
Yellow Perch	48	10	445	844 (196)	178 (115)	7252 (1753)
Walleye	0	0	445	0 (0)	0 (0)	7252 (1753)

SPECIES SPECIFIC ANGLERS

Species	OBSERVED Anglers (#)	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	CUE (#/rd-hr)	HUE (#/rd-hr)
Chinook	3	1	1	9	0.111	0.111
Brown Trout	11	2	2	43	0.047	0.047
Lake Trout	21	38	36	87	0.435	0.414
Northern Pike	23	11	5	57	0.193	0.088
Rock Bass	2	11	8	13	0.846	0.615
Smallmouth Bass	64	132	56	217	0.609	0.258
Largemouth Bass	3	3	3	14	0.211	0.211
Yellow Perch	6	5	5	15	0.341	0.341
Walleye	20	0	0	68	0.000	0.000

Appendix 3. Summary of catch, harvest and effort data from the creel survey conducted at Wellington Government Dock, May 28 to September 18, 1987. A total of 11 samples were taken, and 134 fishing parties were interviewed. Values in parentheses are standard errors.

ALL ANGLERS

Species	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	ESTIMATED Catch (#)	ESTIMATED Harvest (#)	ESTIMATED Effort (rd-hr)
Coho	3	3	1989	70 (31)	70 (31)	35755(11436)
Chinook	368	329	1989	6961 (3874)	5944 (3252)	35755(11436)
Rainbow Trout	28	26	1989	445 (228)	379 (190)	35755(11436)
Brown Trout	10	10	1989	204 (115)	204 (115)	35755(11436)
Lake Trout	28	21	1989	530 (291)	417 (252)	35755(11436)
Lake Whitefish	1	1	1989	40 (39)	40 (39)	35755(11436)
Smallmouth Bass	0	0	1989	0 (0)	0 (0)	35755(11436)

SPECIES SPECIFIC ANGLERS

Species	OBSERVED Anglers (#)	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	CUE (#/rd-hr)	HUE (#/rd-hr)
Coho	5	2	2	31	0.065	0.065
Chinook	239	368	329	1558	0.236	0.211
Rainbow Trout	53	25	23	409	0.061	0.056
Brown Trout	27	10	10	198	0.051	0.051
Lake Trout	32	18	15	232	0.078	0.065
Lake Whitefish	2	1	1	27	0.037	0.037
Smallmouth Bass	3	0	0	7	0.000	0.000

Appendix 4. Summary of catch, harvest and effort data from the creel survey conducted at Brighton Marina, May 28 to September 18, 1987. A total of 19 samples were taken, and 123 fishing parties were interviewed. Values in parentheses are standard errors.

ALL ANGLERS

Species	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	ESTIMATED Catch (#)	ESTIMATED Harvest (#)	ESTIMATED Effort (rd-hr)
Coho	4	4	1632	61 (44)	61 (44)	21727 (3467)
Chinook	251	213	1632	3337 (940)	2907 (808)	21727 (3467)
Rainbow Trout	59	53	1632	800 (246)	721 (218)	21727 (3467)
Brown Trout	4	4	1632	71 (32)	71 (32)	21727 (3467)
Lake Trout	8	2	1632	96 (49)	22 (15)	21727 (3467)
Lake Whitefish	1	0	1632	13 (13)	0 (0)	21727 (3467)
Smallmouth Bass	2	0	1632	26 (25)	0 (0)	21727 (3467)
Yellow Perch	2	0	1632	26 (25)	0 (0)	21727 (3467)

SPECIES SPECIFIC ANGLERS

Species	OBSERVED Anglers (#)	OBSERVED Catch (#)	OBSERVED Harvest (#)	OBSERVED Effort (rd-hr)	CUE (#/rd-hr)	HUE (#/rd-hr)
Coho	14	4	4	100	0.040	0.040
Chinook	177	249	211	1034	0.241	0.204
Rainbow Trout	97	58	52	601	0.097	0.087
Brown Trout	11	4	4	61	0.041	0.041
Lake Trout	17	4	2	99	0.041	0.020
Smallmouth Bass	3	2	0	8	0.257	0.000
Yellow Perch	3	2	0	8	0.267	0.000

Great lake Fishery Commission
Lake Ontario Committee
Gananoque, Ontario
March 8-9, 1988

LAKE ONTARIO CHARTER BOAT QUESTIONNAIRE PROGRAM, 1987

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ABSTRACT

In 1987 the charter boat questionnaire program (Kristmanson and Daniels, 1987) was expanded to include the Ontario Charter Boat Association (OCBA), the Scarborough Charter Boat Association (SCBA), and the Independent Charter Boat Association (ICBA). The number of questionnaires sent increased from 179 in 1986 to 335 in 1987 (Table 1). The response rate varied among associations and seasons ranging from 32 to 51% with an overall rate of 45%. Of these respondents, 93% conducted charters. The reported effort was 129,586 angler-hours corresponding to an expanded estimate of 291,083 angler-hours. Assuming a catch per unit effort of 0.2 to 0.3 salmonids/hour (Daniels and Kristmanson, 1987) the charter boats caught between 58,217 and 87,325 salmonids. Based on the 1987 survey the charter boats accounted for an additional salmonid catch of 32 to 41 % of the launch daily boat catch in the western basin of Lake Ontario. The OCBA accounted for 70% of the estimated total effort (Table 1). Major ports were Grimsby, Burlington, Port Credit, Bluffer's Park and Frenchman's Bay (Table 2). Charter boat activity was highest in the fall (July-September) representing 78% of the total trips and fishing effort (Table 3, Table 4). The average number of trips per month ranged from 3 trips per operator in April to 22 trips per operator in August (Table 3). The mean number of rods per trip were 4.5-4.6 trip lengths were 5.5-5.7 hours, and mean rod hours per trip were 24.9-25.9 (Table 5). The OCBA total fishing effort of 202,698 angler-hours was slightly higher than the 1986 estimate of 181,000. The number of non-member charter boats operating in the western basin of Lake Ontario is unknown.

RECOMMENDATIONS

1) Continue the questionnaire program for at least one more year.

2) Investigate the feasibility of on water surveys in combination with access and aerial surveys to derive direct, statistically sound estimates of total boat fishing effort, salmonid catch and harvest.

REFERENCES

DANIELS, M.E., and J. Kristmanson. 1987. Lake Ontario Charter Boat Questionnaire Program, 1986. Report to the Lake Ontario Comm. GLFC, March 3-4, 1987.

Table 1: Summarized survey results by charter boat association (OCBA = Ontario Charter Boat Association, ICBA = Independent Charter Boat Association, SCBA = Scarborough Charter Boat Association). Members belonging to more than one association were arbitrarily assigned to the first association listed

	April - May			June- September			
	OCBA	ICBA	SCBA	OCBA	ICBA	SCBA	Total
Membership (N)	97	50	32	92	50	27	-
Questionnaires Sent* (n)	94	48	29	90	49	25	335
Receive (r)	45(48%)	20(42%)	13(45%)	40(44%)	25(51%)	8(32%)	151(45%)
Charter Owner Respondents							
Operating	38(84%)	19(95%)	12(92%)	38(95%)	25(100%)	8(100%)	140(93%)
Non Operating	7	1	1	2	0	0	11
Expansion Factor**	2.12	2.44	2.33	2.27	1.98	3.21	-
Reported Effort (angler-hrs.)	19,807	6,736	2,345	70,796	23,984	5,918	129,586
Estimated Effort (angler-hrs.)	41,991	16,436	5,464	160,707	47,488	18,997	291,083
%	14.4	5.7	1.9	55.2	16.3	6.5	-

* excludes mis-addressed and other anomalies

** Expansion factor = $[(n/r) + (N-n/n)]$

TABLE 2: Use of ports by month

Port	April	May	June	Spring Total	%	July	August	September	Fall Total	%	Grand Total	%
St. Catharines	0	0	0	0	0	1	1	1	3	1.4	3	0.8
Port Dalhousie	3	4	2	9	5.8	3	2	2	7	3.3	16	4.3
Snug Harbour	3	3	2	8	5.1	1	1	1	3	1.4	11	3.0
Grimsby	11	10	2	23	14.7	2	2	2	6	2.8	29	7.9
Fifty-Point Marina	0	1	0	1	0.6	2	1	1	4	1.9	5	1.4
Burlington	4	5	6	15	9.6	6	6	7	19	9.0	34	9.2
Bronte	3	4	5	12	7.7	3	3	4	10	4.7	22	6.0
Oakville	1	2	3	6	3.8	3	4	3	10	4.7	16	4.3
Port Credit	5	8	15	28	17.9	21	24	23	68	32.1	96	26.1
Toronto	1	2	2	5	3.2	4	3	3	10	4.7	15	4.1
Bluffer's Park	2	3	8	13	8.3	12	13	12	37	17.5	50	13.6
Frenchman's Bay	6	10	11	17	17.3	7	7	7	21	9.9	48	13.0
Whitby	0	1	1	2	1.3	2	2	1	5	2.4	7	1.9
Oshawa	1	2	4	7	4.5	3	3	3	9	4.2	16	4.3
Total	40	55	61	156	100.0	70	72	70	212	100.0	368	100.0

TABLE 3: Trips per month

Month	# Trips	% Trips within 3-Month Period	% Trips by Month	Mean # Trips/ Operator
April	214	20	5	3
May	389	36	8	5
June	474	44	10	7
July	1,222	34	26	17
August	1,583	43	34	22
September	837	23	18	11
Total	4,719			

TABLE 4: Effort in rod hours by month and location

Port	April	May	June	Spring Total	% of Year	July	Aug.	Sept.	Fall Total	% of Year	Grand Total	%
St. Catharines	0	0	0	0	0	540	540	540	1,620	1.3	0	0
Port Dalhousie	1,127	1,198	573	2,898	2.2	776	588	580	1,944	1.5	4,842	3.7
Snug Harbour	443	1,147	188	1,778	1.4	24	144	264	432	0.3	2,210	1.7
Grimsby	3,268	4,269	236	7,772	6.0	408	642	588	1,638	1.3	9,410	7.3
Fifty-Point Marina	0	336	0	336	0.3	372	450	300	1,122	0.9	1,458	1.1
Burlington	428	684	703	1,815	1.4	936	2,011	1,448	4,394	3.4	6,209	4.8
Bronte	165	765	1,725	2,655	2.0	960	845	465	2,270	1.8	4,925	3.8
Oakville	48	486	1,965	2,499	1.9	7,362	8,184	6,504	22,050	17.0	24,549	18.9
Port Credit	500	835	2,697	4,032	3.1	8,452	16,373	6,298	31,123	24.0	35,155	27.1
Toronto	0	64	368	432	0.3	2,711	960	485	4,165	3.2	4,588	3.5
Bluffer's Park	30	88	1,208	1,326	1.0	5,173	6,712	3,035	14,920	11.5	16,246	12.5
Frenchman's Bay	208	618	1,480	2,305	1.8	1,170	1,092	734	2,996	2.3	5,301	4.1
Whitby	0	40	80	120	0.1	2,130	2,130	810	5,070	3.9	5,190	4.0
Oshawa	0	98	802	900	0.7	2,593	2,864	1,506	6,963	5.4	7,863	6.1
Total	6,216	10,627	12,025	28,868	22.3	33,607	43,535	23,557	100,698	77.7	129,566	100.0

Table 5: Average effort per trip

	Mean # Rods/Trip	Mean Trip Length (hrs)	Mean Rod Hours/ Trip
April - June	4.5	5.5	24.9
July - September	4.6	5.7	25.9

Great Lakes Fisheries Commission
Lake Ontario Committee Meeting
March 7-9, 1988

1987 COMMERCIAL HARVEST SAMPLING IN EASTERN LAKE ONTARIO

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SUMMARY

The commercial harvest sampling project continued in 1987 with no changes in the sampling scheme introduced in 1985. The sampling design provides even coverage across all types of fisheries, and the collection of the data on the biological attributes of the fish is limited to size distribution data. In 1987, we took samples from 531 landings (Tables 1 and 2). This total includes the samples obtained from the whitefish sampling program (see Section 3 of this report). The total does not include landings from mixed gear-types or mixed quota zones.

RECOMMENDATIONS

1. Discontinue the program until access to on board sampling is guaranteed.

Table 1. Summary of the number of fishing trips sampled in the 1987 commercial harvest sampling program (January to December).

Gear Type	Quota Zone						
	1	2.1	2.2	3	4	5	Total
Gillnet	12	70	150	7	99	0	338
Trapnet	4	7	10	0	0	0	21
Hoopnet	16	3	2	57	2	1	81
Hookline	0	54	12	10	9	2	87
Electrofishing	0	4	0	0	0	0	4
Total	32	138	174	74	110	3	531

Table 2. Summary of the number of fish sampled in the 1987 commercial harvest sampling program (January to December).

Species	Quota Zone						
	1	2.1	2.2	3	4	5	Total
Lake Whitefish	3	0	9090	3	2388	0	11484
Lake Herring	426	0	835	0	50	0	1311
American Smelt	0	0	20	0	0	0	20
White Sucker	0	0	0	515	1	0	516
Carp	0	0	0	21	0	0	21
Brown Bullhead	458	0	117	2623	186	0	3384
Channel Catfish	1	5	2	110	55	0	173
American Eel	147	1730	373	523	96	93	2962
White Perch	44	143	144	2033	524	0	2888
White Bass	14	16	92	4	1	0	127
Rock Bass	405	142	410	755	23	4	1739
Pumpkinseed	385	0	28	1895	32	3	2343
Bluegill	507	0	1	25	0	0	533
Black Crappie	318	0	16	240	15	2	591
Yellow Perch	970	4434	1973	2000	2464	11	11852
Freshwater Drum	0	2	9	47	1	0	59
Total	3678	6472	13110	10794	5836	113	40003

Great Lakes Fishery Commission
Lake Ontario Committee Meeting
March 8-9, 1988

SUMMARY OF THE 1987 COMMERCIAL FISH HARVEST IN EASTERN LAKE ONTARIO

Napanee District staff
Napanee, Ontario

1987 REPORTED LANDINGS (ROUND POUNDS)

SPECIES	1986 LANDINGS	1987 LANDINGS	1987 AVERAGE $	1987 VALUE
Bullheads	480,388	401,732	0.36	$144,623.52
Carp	121,322	75,101	0.38	28,538.38
Catfish	14,367	23,446	0.62	14,536.52
Crappies	31,666	22,210	1.44	31,982.40
Eels	229,044	194,892	1.04	202,687.68
Drum	7,602	7,558	0.18	1,360.44
Lake Herring	2,947	4,826	0.50	2,413.00
Lake Whitefish	126,434	125,807	1.02	128,323.14
Menominee	112	2,850	0.85	2,422.50
Rock Bass	26,238	24,067	0.29	6,979.43
Smelt	2,017	36	0.00	0.00
Sunfish	71,373	62,418	0.18	11,235.24
Suckers	33,315	12,679	0.21	2,662.59
White Bass	11,894	1,538	0.59	907.42
White Perch	118,994	163,191	0.48	78,331.68
Yellow Perch	472,722	304,173	1.10	334,590.30
Dogfish	5,851	7,704	0.20	1,540.80
Industrial	3,879	18,260	0.00	0.00
Turtles	2,060	1,895	0.25	473.75
Totals	1,765,207 (for value of $1,377,085.51)	1,454,383		$993,608.79

Great Lakes Fisheries Commission
Lake Ontario Committee
Gananoque, Ontario
March 8-9, 1988

INDEX GILLNETTING PROJECT, 1987

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ABSTRACT

Yellow perch CUE's in the Kingston Basin of Lake Ontario have declined in 1987 from 1986. The size of the yellow perch present has increased. The yellow perch CUE at Brighton has declined and the perch present are very small. Differences in the catches of several warm water fish species in the Kingston Basin suggest that the Flatt Point transect differs from the Grape Island and Melville Shoal transects.

RECOMMENDATIONS

1. Continue the current index series in the Kingston Basin.

2. Start a new series of index transects in the Central Basin of Lake Ontario.

INTRODUCTION

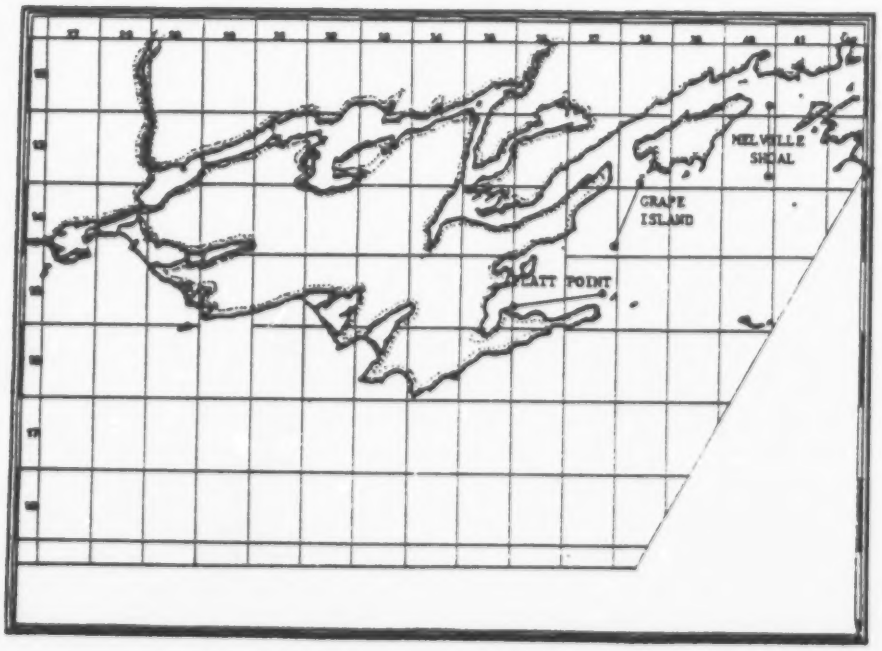
During 1986, the Lake Ontario Fisheries Assessment Unit instituted a new index gillnetting program in the Kingston Basin of Lake Ontario. This program replaced the yellow perch index program which was run in the Kingston Basin from 1976 to 1985. The new program allows investigation of the variability in catches of warm water fish species across depth and spatial strata. This report presents a summary of the 1987 catch and a comparison of these data to the 1986 catch.

METHODS

Sampling at the Simcoe Island and Halfmoon Bay traditional sites in the Kingston Basin was discontinued in 1987. The sampling at the traditional site at Brighton was continued with four lifts during the month of August. The index transects established in 1986 (Flatt Point, Grape Island, and Melville Shoal) were maintained (Figure 1). Gillnets were set over night (set mid afternoon, lifted mid morning) at six depths along each of the three transects. The sampling was repeated 3 times on a rotational basis between July 20 and August 28. Gill nets were set parallel to the depth contours at approximately the midpoint of each of the following strata:

1 - 0 to 5 m	2 - 5 to 10 m	3 - 10 to 15 m
4 - 15 to 20 m	5 - 20 to 25 m	6 - 25 to 30 m

Figure 1. LOFU index gillnet transects in the Kingston Basin of Lake Ontario.



Gillnets used were the Glenora Fisheries Station standard lake gillnets which consist of eight panels (stretched mesh sizes): 5 yards of 1.5" mesh, 25 yards of 2" mesh, and 50 yards of 2.5", 3", 4.5", and 5" meshes. Shorter lengths of the 1.5" and 2" meshes were used to avoid large catches of alewife.

For yellow perch, alewife, smelt, and walleye the following data were recorded for each lift:

1 - all fish were counted by species for each mesh size.
2 - aggregate weight by species for each mesh size.
3 - fork length tally (in 1 cm intervals) by species for each mesh size to a maximum of 100 fish.
4 - biosample from the first 30 fish in each 1 cm fork length size class regardless of the netting location and mesh size.

Fish of all other species were biosampled. Biosample means fork length, weight, scale sample, sex, clips, marks, and tags. Coded wire tags were removed from the heads of lake trout with an adipose clip.

ANALYSIS

During analysis, catches from each gillnet panel (mesh size) were extrapolated to 100 meters and then the catches from each panel were added by species to produce a standardized catch for each gillnet lift. These data were transformed ($\ln(x + 1)$) and analysis of variance (using the SAS GLM procedure) were performed to compare the catch data for individual species from 1987 and 1986. Least-square means (LSMEANS option of the GLM procedure) were calculated to test for differences between means. The least-square means (referred to as 'adjusted means' from here on) represent values which are adjusted for unequal variation in their covariates to allow easy comparison.

Water temperature recorded at the gillnet was used as a covariate to the CUE. Year, area, depth and their first order interaction terms were all included in a preliminary analysis. The results of the preliminary analysis were examined and insignificant sources of variation were removed from the ANOVA model before the final analysis was performed. Type III sums of squares were used in all analyses.

RESULTS

(i) Kingston Basin - General

Twenty-five species of fish were captured during the 1987 Index Gillnetting Program (Appendix 1). Yellow perch, walleye, rock bass, white perch, smallmouth bass, alewife, lake trout and smelt were selected for analysis because their overall standardized CUE was greater than or equal to one.

Water temperature has been shown in the past to have a strong influence on the distribution of the above fish species - with the exceptions of yellow perch and alewife (Malone et al. 1986). Prior to comparing the catches of the various fish species the water temperatures at the gillnets were compared to see if any differences between 1986 and 1987 might confound the

species catch analysis. The adjusted mean water temperature in 1987 (17.2°C, 95% Confidence Limits 16.5 to 17.8) was significantly higher (ANCOVA, p=0.0337) than during 1986 (16.1°C, 95% C.L. 15.4 to 16.8). Since the water temperature was different between 1986 and 1987 this factor was incorporated into the analysis of the catches of fish species.

(ii) Yellow Perch - Kingston Basin

The yellow perch population appears to have declined in the Kingston Basin. ANOVA suggested that the yellow perch catches in 1987 were significantly smaller than in 1986 (Table 1 and Figure 2). The adjusted geometric mean CUE in 1987 was 50.3 (95% C.L. 40.9 to 61.8) while it was 101.9 (95% C.L. 83.0 to 124.9) in 1986. Gillnets set at Simcoe Island and Halfmoon Point between 1980 and 1985 provided data which suggested that the yellow perch population in the Kingston Basin was declining during this period (Malone *et al.*, 1986). The analysis presented here suggests that this trend is continuing.

This analysis also suggested that there were significant differences in the yellow perch catches between areas. Examination of the adjusted geometric means from the areas of the Kingston Basin gillnetted showed that the CUE's from Flatt Point were significantly smaller than those from Grape Island and Melville Shoal (Table 2).

Yellow perch were caught at all water depths and temperatures. Perch catches were not correlated to water temperature in a simple fashion. This was also found in the 1986 program (Malone *et al.*, 1987). CUE's were significantly different between water depths - catches at 12.5 m, 17.5 m, and 22.5 m were larger than CUE's at other water depths.

The mean fork length of the yellow perch caught during 1987 at the Melville Shoal and Grape Island areas has increased from 1986 (Figure 3). The mean fork of the catch at Flatt Point during 1987 has not changed appreciably from 1986. Fork length at age data is presented in Figure 4 and the sexual maturity of female yellow perch is presented in Figure 5.

Table 1. Analysis of variance in catch per effort data from 1986 and 1987 in dex gillnetting programs in the Kingston Basin of Lake Ontario. Year, area, depth and water temperature (and all first order interaction terms) were all considered as sources of variation in the initial ANOVA runs. The significant sources of variation are presented for each species. Sample size was 103 lifts.

Species	Source	'F' statistic	PR >'F'
Alewife	Temperature (+)	5.56	0.0204
	Year	10.73	0.0015
	Area	15.83	0.0001
Lake Trout	Temperature (-)	43.60	0.0001
	Area	12.31	0.0001
	Depth	7.56	0.0001
	Temperature*Area	7.88	0.0007
Smelt	Temperature (-)	10.20	0.0019
	Year	3.23	0.0755
	Area	5.26	0.0069
	Depth	38.63	0.0001
	Temperature*Year	2.94	0.0900
	Temperature*Area	3.52	0.0338
White Perch	Temperature (+)	42.76	0.0001
	Year	2.26	0.1363
	Area	2.56	0.0828
	Temperature*Year	4.34	0.0399
	Temperature*Area	5.31	0.0065
Rock Bass	Temperature (+)	3.77	0.0557
	Depth	5.49	0.0002
	Area*Depth	6.42	0.0001
	Temperature*Depth	5.34	0.0003
Smallmouth Bass	Temperature (+)	13.88	0.0003
	Area	4.48	0.0140
	Depth	2.69	0.0256
	Temperature*Area	10.70	0.0001
Yellow Perch	Year	5.90	0.0170
	Area	19.30	0.0001
	Depth	10.39	0.0001
Walleye	Temperature (+)	21.22	0.0001
	Area	4.87	0.0099
	Depth	2.32	0.0502
	Temperature*Area	11.16	0.0001
	Temperature*Depth	3.86	0.0033

(+) positive relationship between water temperature at the gillnet and CUE
(-) negative relationship between water temperature at the gillnet and CUE

Table 2. Mean CUE of warmwater fish species caught in gillnets in the Kingston Basin. The values presented are adjusted geometric means with their 95% confidence limits. CUE's for a species which were not significantly different among locations were given the same superscript.

Species	Flatt Point	Grape Island	Melville Shoal
Alewife	543.0[a](392.0 to 752.0)	272.6[a](193.2 to 384.4)	41.2[b](29.2 to 58.1)
Lake Trout	1.0[c](0.8 to 1.3)	1.5[b](1.2 to 1.8)	3.7[a](3.1 to 4.3)
Smelt	2.7[a](2.2 to 3.2)	1.4[b](1.0 to 1.7)	3.8[a](3.2 to 4.5)
White Perch	0.2[b](0.1 to 0.4)	2.5[a](1.9 to 3.1)	1.6[a](1.2 to 2.0)
Smallmouth Bass	0.4[c](0.2 to 0.6)	4.6[b](3.8 to 5.4)	8.5[a](7.2 to 9.9)
Yellow Perch	19.7[a](15.1 to 25.5)	138.4[b](107.8 to 177.6)	132.2[b](102.9 to 169.7)
Walleye	-0.1[b](-0.2 to 0)	1.7[a](1.3 to 2.2)	2.1[a](1.6 to 2.8)

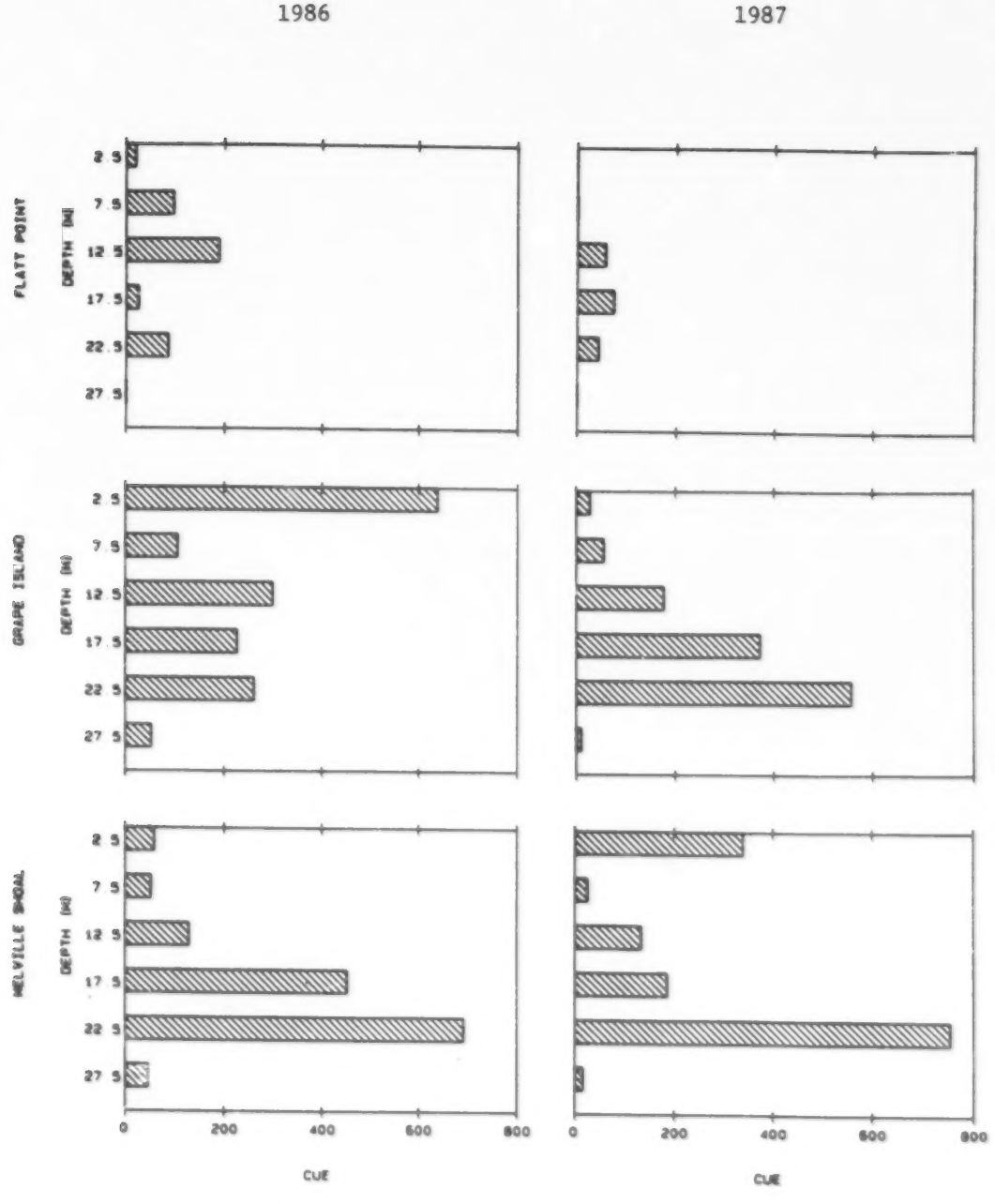


FIGURE 2. Geometric mean yellow perch CUE at the various depths along the LOFU index gillnet transects in the Kingston basin.

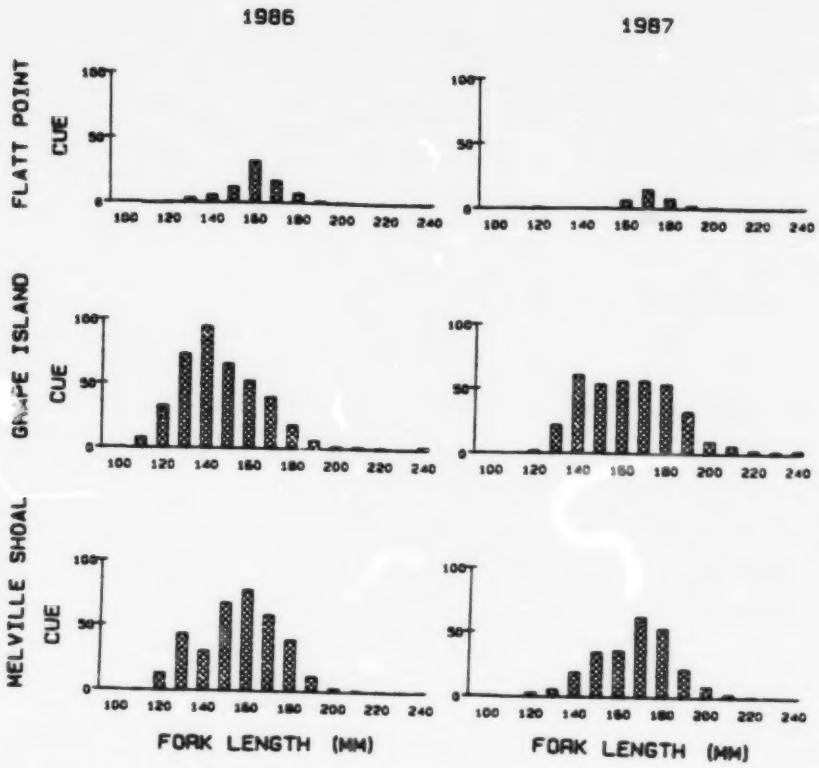


FIGURE 3. Yellow perch fork length distribution histograms from the LOFU index gillnets in the Kingston basin.

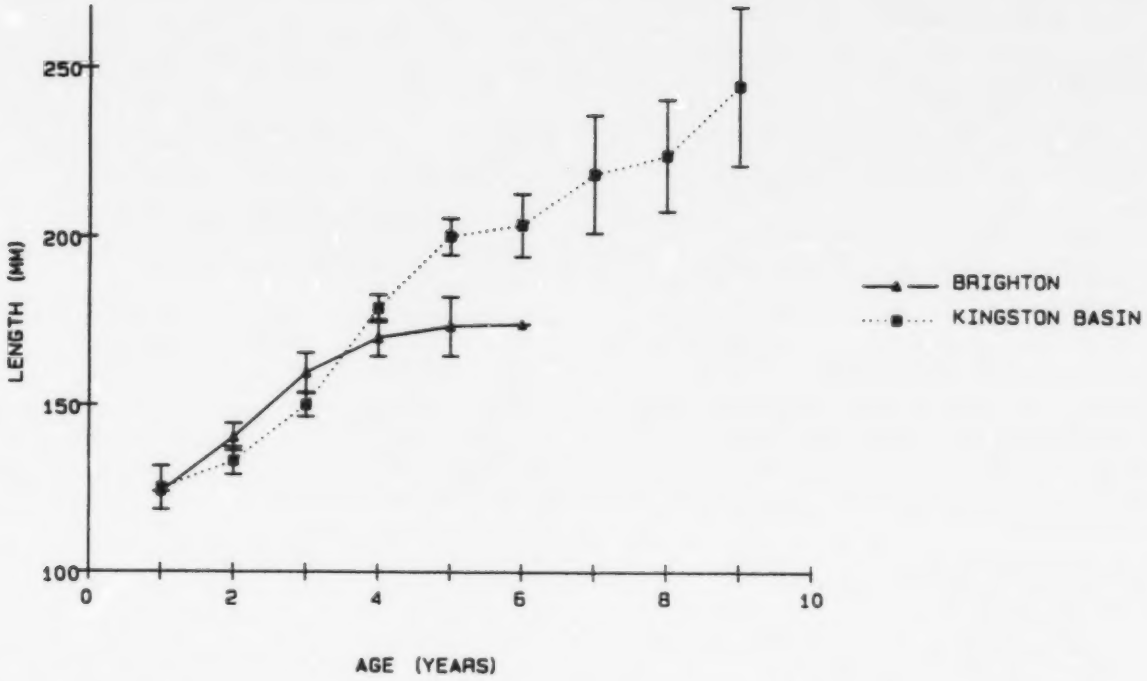


FIGURE 4. Yellow perch fork length at age data from the LOFU index gillnets in the Kingston basin and at Brighton.

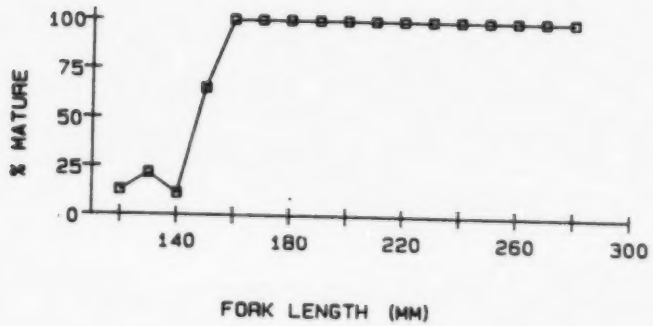


FIGURE 5. Sexual maturity of female yellow perch from the LOFU index gillnets in the Kingston basin.

(iii) Other Species - Kingston Basin

Alewife, white perch, smallmouth bass, rock bass and walleye catches were all positively correlated with water temperature (Table 1 and Figure 6). Alewife are somewhat unique in this group because large numbers of fish of this species were caught at all water depths and temperatures. The alewife CUE in 1987 (adjusted geometric mean 96.8, 95% C.L. 74.0 to 126.6) showed a significant decrease from 1986 (adjusted geometric mean 347.1, 95% C.L. 262.1 to 459.5). All other warm water species showed no significant changes between years. The catches of several of the warm water species analyzed (white perch, smallmouth bass, and walleye) showed significant variation between areas (Table 2). In particular, the catches of all of these species were significantly lower at Flatt Point than at the other two netting areas. This could be due the relatively small area of littoral zone at this location.

The catch data of lake trout and smelt were both negatively correlated with water temperature (Table 1). The data from these two cold water species suggests there are no significant differences in their catches between years. Both species did show significant depth and area effects.

(iv) Yellow Perch - Brighton

The yellow perch CUE at Brighton has declined again to the low levels observed prior to 1986 (Figure 6). The high CUE observed in 1986 (due primarily to a large number of small fish) was not observed. The mean size of the yellow perch observed at Brighton is much smaller than those caught in the Kingston Basin. The mean fork length of the 1987 catch at Brighton was smaller in size than in any previous year (Figure 7). Fork length at age data from Brighton shows that the two and three year old fish are large relative to the Kingston Basin yellow perch (Figure 4). On the other hand, four and five year old fish from Brighton are smaller than those from the Kingston Basin. This change in the size at age structure of the population could be caused by overfishing with size selective gillnets.

REFERENCES

MALONE, B., W. DENTRY, and T. SCHANER. 1986. Index gillnetting project. Lake Ontario Fisheries Unit, Ontario Ministry of Natural Resources, Internal Report LOA 86.14.

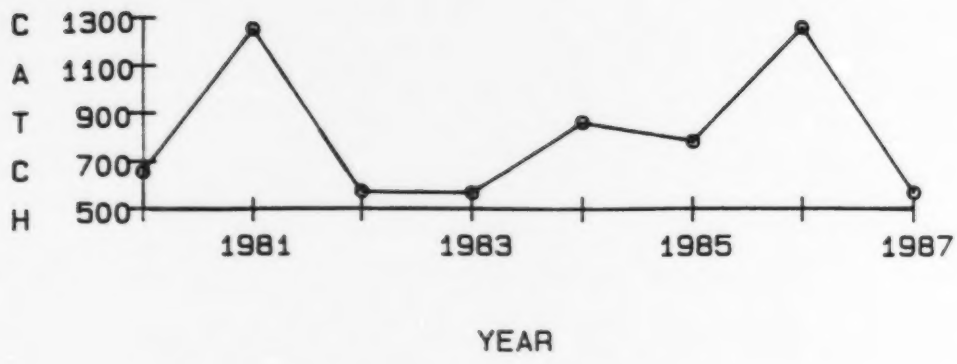


FIGURE 6. Yellow perch CUE from the LOFU index gillnets at Brighton.

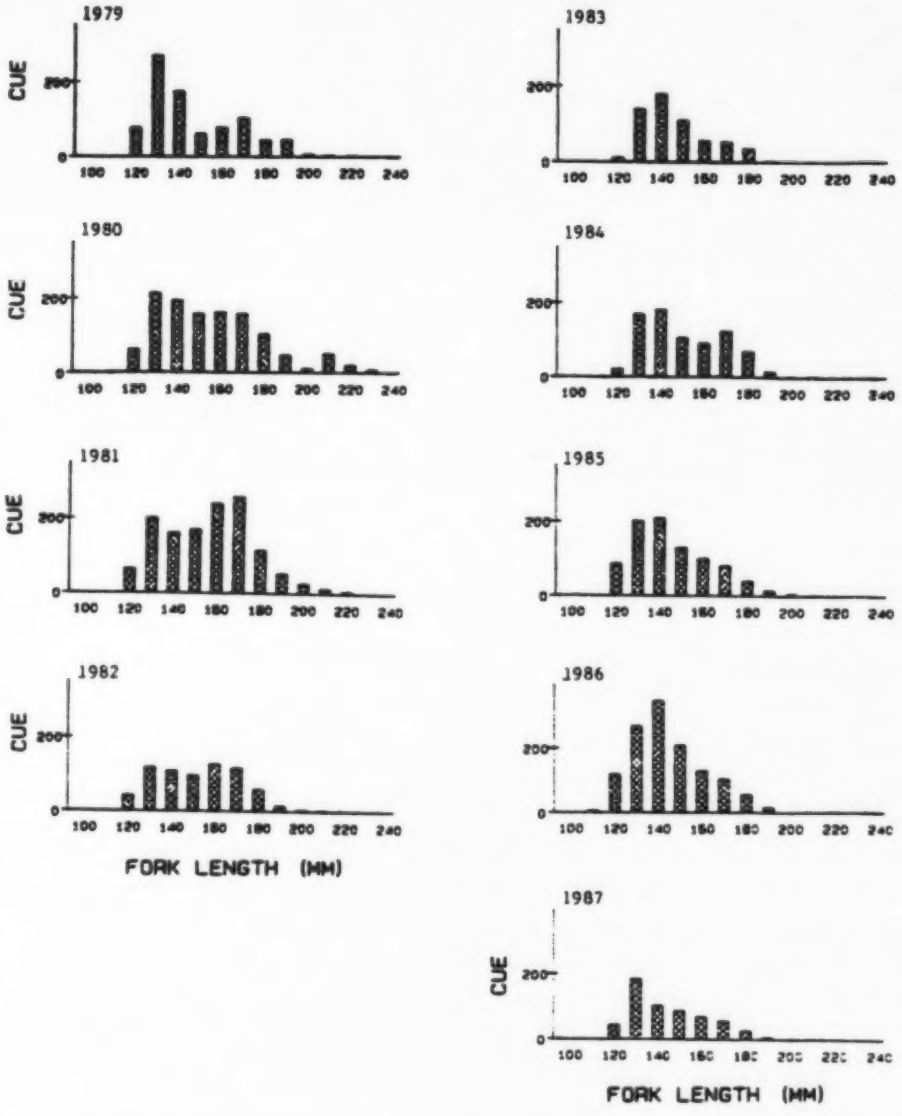


FIGURE 7. Fork length distribution histograms from the LOFU index gillnets at Brighton.

APPENDIX 1 - STANDARD CATCH IN 1987 INDEX GILLNETS

These data are standardized (see Analysis section) CUE's from the 1987 Index Gillnetting conducted by LOFU in the Kingston Basin of Lake Ontario. The gillnets were set along three transects : FP - Flatt Point, GI - Grape Island, MS - Melville Shoal. The temperatures given are water temperature recorded at the gillnet. Species codes used as column headings in the Appendix are shown below.

SPC 61 - Alewife
SPC 63 - Gizard Shad
SPC 75 - Chinook Salmon
SPC 77 - Atlantic Salmon
SPC 78 - Brown Trout
SPC 81 - Lake Trout
SPC 91 - Lake Whitefish
SPC 93 - Lake Herring
SPC 102 - Coregonus sp.
SPC 121 - Rainbow Smelt
SPC 131 - Northern Pike
SPC 163 - Common White Sucker
SPC 177 - Moxostoma sp.
SPC 233 - Brown Bullhead
SPC 234 - Channel Catfish
SPC 235 - Stonecat
SPC 291 - Trout Perch
SPC 301 - White Perch
SPC 302 - White Bass
SPC 311 - Rock Bass
SPC 313 - Pumpkinseed
SPC 316 - Smallmouth Bass
SPC 331 - Yellow Perch
SPC 334 - Walleye
SPC 371 - Freshwater Drum

SAMPLE #	TRANSECT	DEPTH	TEMP	SPC61	SPC63	SPC75	SPC77	SPC78	SPC81	SPC91
1	FP	2.5	18.5	1581.5	0	0	0	0	0	0
2	FP	7.5	17.5	443.9	0	0	0	0	0	0
3	FP	12.5	17.0	989.9	0	0	0	0	0	0
4	FP	17.5	17.5	337.2	0	8.8	0	0	0	0
5	FP	22.5	15.2	81.0	0	2.2	0	2.2	2.2	0
6	FP	27.5	12.2	735.6	0	21.9	0	0	15.3	0
7	GI	2.5	21.0	122.6	2.2	0	0	0	0	0
8	GI	7.5	20.0	2277.3	0	0	0	0	0	0
9	GI	12.5	18.5	3503.9	0	0	0	0	0	0
10	GI	17.5	18.5	58.9	0	2.2	0	0	0	0
11	GI	22.5	17.0	205.1	0	0	0	4.4	0	0
12	GI	27.5	15.0	250.2	0	2.2	0	0	8.8	0
13	MS	2.5	22.0	259.0	2.2	0	0	0	0	0
14	MS	7.5	21.5	489.5	2.2	0	2.2	0	0	0
15	MS	12.5	21.0	522.5	0	0	0	0	0	0
16	MS	17.5	21.0	677.0	0	0	0	0	0	0
17	MS	22.5	20.0	102.7	0	0	0	0	2.2	0
18	MS	27.5	12.0	0	0	2.2	0	0	72.2	6.6
19	FP	2.5	19.5	1183.4	0	0	0	0	0	0
20	FP	7.5	18.5	680.8	0	0	0	2.2	0	0
21	FP	12.5	18.5	1356.4	0	2.2	0	0	0	0
22	FP	17.5	18.5	2846.7	0	0	0	0	0	0
23	FP	22.5	17.0	43.8	0	0	0	0	0	0
24	FP	27.5	15.0	632.1	0	15.3	0	2.2	0	0
25	GI	2.5	22.0	278.7	0	0	0	0	0	0
26	GI	7.5	21.0	489.4	2.2	0	0	0	0	0
27	GI	12.5	20.0	135.3	0	0	0	0	0	0
28	GI	17.5	20.0	633.5	2.2	0	0	0	0	0
29	GI	22.5	17.5	191.6	0	0	0	0	2.2	0
30	GI	27.5	13.0	4.4	0	4.4	0	0	0	2.2
31	MS	2.5	22.0	4.4	0	0	0	0	0	0
32	MS	7.5	20.0	0	0	0	0	0	0	0
33	MS	12.5	18.5	0	0	0	0	0	0	0
34	MS	17.5	11.5	54.6	0	2.2	0	4.4	41.6	0
35	MS	22.5	13.0	23.9	0	8.8	0	0	74.4	0
36	MS	27.5	10.5	6.6	0	2.2	0	0	107.2	6.6
37	FP	2.5	21.0	1111.0	0	0	0	0	0	0
38	FP	7.5	20.0	61.0	2.2	0	0	0	0	0
39	FP	12.5	20.0	141.4	0	0	0	0	0	0
40	FP	17.5	14.0	211.0	0	2.2	0	0	0	0
41	FP	22.5	12.5	324.2	0	4.4	0	2.2	2.2	0
42	FP	27.5	12.0	352.5	0	6.6	0	0	32.8	0
43	GI	2.5	21.0	128.4	2.2	0	0	0	0	0
44	GI	7.5	20.0	50.0	0	0	0	0	0	0
45	GI	12.5	20.0	154.4	0	0	0	0	0	0
46	GI	17.5	13.0	139.6	0	2.2	0	2.2	2.2	0
47	GI	22.5	9.0	276.3	0	2.2	0	0	67.9	8.8
48	GI	27.5	8.5	0	0	0	0	0	107.2	24.1
49	MS	2.5	19.0	2.2	0	0	0	0	0	0
50	MS	7.5	20.5	0	0	0	0	0	0	0
51	MS	12.5	19.5	0	0	0	0	0	0	0
52	MS	17.5	13.5	107.1	0	2.2	0	0	4.4	0
53	MS	22.5	9.5	4.4	0	0	0	0	54.7	0
54	MS	27.5	8.0	21.7	0	0	0	0	251.4	8.8

SAMPLE #	SPC93	SPC102	SPC121	SPC131	SPC163	SPC177	SPC233	SPC234	SPC235	SPC291
1	0	0	0	4.4	0	0	0	0	0	0
2	0	0	0	0	0	0	2.2	0	0	0
3	0	0	0	0	2.2	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	6.6	0	0	0	0	0	0	0
6	8.8	0	194.8	0	0	0	0	0	0	0
7	0	0	0	0	0	0	4.4	0	0	0
8	0	0	0	0	2.2	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	6.6	0	4.4	0	0	0	0	0	0	0
12	2.2	0	4.4	0	0	0	0	0	0	0
13	0	0	0	0	0	2.2	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	2.2	0	0	0	0	0
16	0	0	0	0	2.2	0	0	2.2	0	0
17	2.2	0	2.2	0	2.2	0	0	0	0	0
18	0	0	284.2	0	2.2	0	0	0	0	0
19	0	0	0	2.2	4.4	0	30.7	0	0	0
20	0	0	0	4.4	4.4	0	30.5	0	0	0
21	0	0	0	0	4.4	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	4.4
24	4.4	0	260.0	0	0	0	0	0	0	0
25	0	0	0	0	2.2	0	11.0	0	0	0
26	0	0	0	0	0	0	0	2.2	0	0
27	0	0	0	0	2.2	0	0	0	0	0
28	0	0	0	0	0	0	4.4	0	0	0
29	0	0	0	0	0	0	0	0	0	2.2
30	4.4	2.2	61.3	0	0	0	0	0	0	0
31	0	0	0	2.2	0	6.6	0	13.1	0	0
32	0	0	0	0	0	2.2	0	2.2	0	0
33	0	0	0	0	0	0	0	0	0	0
34	4.4	0	6.6	0	0	0	0	0	0	43.5
35	0	0	54.6	0	0	0	0	0	0	0
36	2.2	0	100.7	0	0	0	0	0	0	0
37	0	0	0	6.6	0	0	32.7	2.2	0	0
38	0	0	0	2.2	4.4	0	0	0	0	0
39	4.4	0	0	0	8.8	0	4.4	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	6.6	0	15.3	0	0	0	0	0	0	0
42	26.1	0	135.6	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	2.2	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0
46	2.2	0	0	0	0	0	0	0	0	0
47	4.4	0	48.2	0	0	0	0	0	0	0
48	2.2	4.4	360.1	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	2.2	0	0	0	4.4	0
52	0	0	19.7	0	0	0	0	0	0	0
53	2.2	0	10.9	0	0	0	0	0	0	0
54	0	0	336.6	0	0	0	0	0	0	0

SAMPLE #	SPC301	SPC302	SPC311	SPC313	SPC316	SPC331	SPC334	SPC371
1	2.2	0	87.1	0	2.2	0	0	0
2	0	0	15.3	0	2.2	0	0	0
3	2.2	0	10.9	0	0	43.7	0	2.2
4	0	0	10.9	0	0	41.7	0	0
5	0	0	0	0	0	57.0	0	0
6	0	0	2.2	0	0	0	0	0
7	13.1	0	365.1	0	37.2	61.4	24.1	4.4
8	0	0	65.7	0	17.5	65.8	4.4	0
9	0	0	83.2	0	19.7	411.3	4.4	0
10	0	0	113.4	0	6.6	578.4	6.6	0
11	0	0	0	0	0	229.5	0	0
12	0	0	0	0	0	0	0	0
13	8.8	0	54.6	0	30.6	1690.2	72.2	0
14	0	0	35.1	0	48.1	120.0	26.3	0
15	0	0	92.0	0	35.0	486.1	37.1	0
16	0	0	21.9	0	54.7	270.0	0	2.2
17	0	0	28.5	0	30.7	1694.8	0	0
18	0	0	0	0	2.2	24.1	0	0
19	0	0	70.0	4.4	11.0	4.4	2.2	0
20	0	0	24.1	0	0	4.4	0	0
21	0	0	4.4	0	0	63.6	0	0
22	0	0	13.1	0	2.2	153.5	0	0
23	0	0	0	0	0	83.3	0	0
24	0	0	0	0	0	13.2	0	0
25	32.7	2.2	57.0	0	13.1	34.9	19.7	8.8
26	34.9	0	113.7	0	56.9	15.3	8.8	4.4
27	0	2.2	172.8	0	26.3	102.7	41.5	6.6
28	28.5	0	209.9	0	10.9	493.3	8.8	6.6
29	6.6	0	17.5	0	0	1378.8	0	0
30	0	0	0	0	0	98.5	0	0
31	89.3	0	17.5	0	19.7	332.0	65.6	4.4
32	37.1	0	15.3	0	26.3	17.5	56.9	10.9
33	2.2	0	67.7	0	28.4	54.6	6.6	0
34	0	0	15.3	0	8.8	379.3	2.2	0
35	0	0	4.4	0	2.2	767.0	0	0
36	0	0	0	0	0	8.8	0	0
37	0	0	0	0	0	0	10.9	0
38	2.2	0	13.1	4.4	0	2.2	4.4	17.5
39	0	0	30.7	2.2	0	70.2	0	0
40	0	0	0	0	0	65.8	0	0
41	0	0	0	0	0	17.5	0	0
42	0	0	0	0	0	0	0	0
43	13.2	0	24.1	0	37.2	11.0	52.6	26.3
44	2.2	0	115.9	0	56.9	172.6	56.9	2.2
45	0	0	59.1	0	17.5	133.4	4.4	0
46	0	0	130.6	0	0	181.6	2.2	0
47	0	0	0	0	0	548.8	0	0
48	0	0	0	0	0	17.5	0	0
49	0	0	72.0	0	6.6	70.0	30.6	2.2
50	0	0	46.0	0	39.4	8.8	13.1	2.2
51	2.2	0	67.9	0	37.2	91.7	11.0	0
52	0	0	2.2	0	8.8	63.6	0	0
53	0	0	0	0	0	330.9	0	0
54	0	0	0	0	0	26.1	0	0

Great Lakes Fishery Commission
Lake Ontario Committee Meeting
March 8-9, 1988

COMMUNITY ORIENTED LAKE ASSESSMENT (COLA)

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INTRODUCTION

The Community Oriented Lake Assessment program (COLA) was spurred by the recent trends in fisheries science towards community management, and represents the logical outcome of several events in the province of Ontario. The Strategic Plan for Ontario Fisheries (SPOF) has identified as one of its major elements the need for a broad knowledge base in order to manage fisheries effectively. Community interactions and their assessment were the theme of the ASPY symposium, which also outlined some of the information needs in assessment and management of the Great Lakes fisheries. Finally, the introduction of resident angling fee in the province of Ontario has provided the funds necessary to undertake a community assessment program.

Events occurring around Lake Ontario have also influenced the formulation of the COLA program. The Lake Ontario Fisheries Unit (LOFU) together with the American state and federal agencies have been examining the possibility of unifying their individual sampling efforts into a single lake-wide program, and trial cooperative fishing has been ongoing since 1985. These efforts have, however, been directed towards individual fish species, while there is a feeling that a broader knowledge of the entire fish community would be beneficial in answering resource management questions. The COLA program is thus perceived by the agencies around the lake as very timely. It is also felt that a cooperative approach would greatly enhance the chances for eventual introduction of a lake-wide community monitoring scheme.

In early 1987 the COLA steering committee was formed. W. Dentry (OMNR) and G. LeTendre (NYDEC) were named as co-chairmen, with G.Beggs (OMNR) and J. Elrod (USFWS) being the other members. Soon thereafter, the committee formulated the goals and objectives of the program. When the discussions started moving towards the practical aspects of the program it became apparent that a group of people with more intimate involvement with the field programs was required to translate the mandate into a workable sampling proposal. The technical committee was formed, consisting of Dr. B.Henderson (OMNR), R.O'Gorman (USFWS), T.Schaner (OMNR) and C.Schneider (USFWS). In August 1987 J.Christie

(OMNR) joined the steering committee, replacing G.Peggs who has decided to step down because of her increasing work load as the provincial Assessment Unit Coordinator.

THE SCOPE OF COLA

The COLA program is planned as a five year undertaking, starting in fiscal year 1987/88. The current year has been devoted to clarification of the objectives and ways to fulfill them, and to a review of the fisheries data collected on the lake in the past. A vessel, R/V *STEELCRAFT*, is also being outfitted to enable us to effectively sample fish on the open lake using several types of gear. In the next four years we will develop a lake wide community sampling program. After the completion of the five year COLA program we will be in position to embark upon an assessment data collection series.

THE MANDATE

The goal and the objectives of the program have evolved since their first definition, reflecting the need for a reasonably precise statement of expectations, and one which is achievable within the allotted time and resources. The overall goal of the program is defined as follows:

> To assess the status of the fish community of Lake Ontario, and to develop an understanding of the system and an ability to predict the responses of its fish stocks to stresses and management.

The way to achieve the the goal has been outlined in a set of long and short term objectives. The long term objectives are those that should be accomplished by COLA but may not necessarily be completed in the five year time frame. The short term objectives can be completed within five years.

> Long term objective #1: To establish lake wide trend-through-time indices of abundance of individual fish stocks, and to determine the abundance of the fish stocks relative to each other.
>
> > Short term objective #1: To develop sampling program(s) to index the abundance of individual fish stocks.
>
> Long term objective #2: To develop predictive model(s) of the functional relationships of the major Lake Ontario fish communities.

Short term objective #2: To describe the composition of the major fish communities seasonally and spatially within the central basin of Lake Ontario (area bounded by the Scotch Bonnet and Main Duck sills).[1]

Long term objective #3: To compare observed changes in the fish communities with predicted changes, and iteratively refine the model(s).

FISHERIES SURVEYS ON LAKE ONTARIO

This section presents a brief overview of the data collection programs conducted on Lake Ontario in the past and at the present. The intent is to describe the sampling coverage and the extent of our knowledge about the fish communities in the lake. The information, or the lack of it, should be one of the factors in determining the course of COLA.

The major portion of the past data from the open Lake Ontario has been collected in the programs run by the Glenora Fisheries Station (GFS). More recently the former Lake Ontario Fisheries Assessment Unit (LOFAU, now the Lake Ontario Fisheries Unit, LOFU) has initiated data collection series, but the extent of the work on the open lake has been limited. During the IFYGL year (1972-73) there has been an attempt to sample all habitats in the lake, and the data from that year offer more comprehensive information in addition to the long term data series.

The GFS lake gillnet series offers the most extensive and consistent data from the past. The bulk of the data are from July and August, mainly in the Kingston Basin. In this area the sampling was restricted to the 20-50 metre stratum (actually most sets were made at about 30 m depth). The main lake is represented by three index transects sampled again most consistently in July and August, and having a limited depth coverage.

The analysis of the gillnet data was undertaken by B.Henderson (unpubl.) He restricted the data set to the Kingston Basin stations between 20 and 40 m, and to the months of July and August. Furthermore, only the meshes at 0.5 inch intervals between 2 and 4.5 inches, and only sets that contained those meshes, were used. Rainbow smelt and alewife were found to be the dominant species in the catch, and lake trout were also found in significant numbers in the last decade. The catches of all other species were too small and variable for further analysis. Similarly, my survey of the complete data set showed only smelt and alewife to be present in more than 50% of the catches, followed by another seven species present between 10 and 25% (in order of presence: lake trout,

1. The basin designation in Lake Ontario is confusing and not well established. This document refers to the area west of the Scotch Bonnet Sill as the Western Basin, the area between the Scotch Bonnet and Main Duck sills as the Central Basin, and the area north of the Main Duck Sill (exclusive of the North Channel and the Bay of Quinte) as the Kingston Basin.

rock bass, common white sucker, yellow perch, smallmouth bass, white perch, and the sculpins). I also found that the variability of catches even for these species was high relative to the mean catch.

The GFS bottom trawling is another consistent long term data series. The fishing here is restricted to six stations in the Kingston Basin, all approximately at the 30 m depth. These data were also analyzed by B.Henderson, showing again that alewife and rainbow smelt were the predominant species in the catch, and that other species were not caught consistently enough to allow further analysis (trout perch in one stratum were an exception).

Other programs conducted by the MNR on the lake are less extensive. The index gillnetting program was initiated in 1976 by LOFAU. This program sampled the warmwater community at two index stations in the Kingston Basin and one on the main lake off Brighton. Only a single depth was sampled at each station, and sampling was conducted over the entire summer at regular intervals. The analysis of the data (Schaner 1985) showed that there were complex trends in the catch composition and species abundances over the course of the summer season, and experimental sets in 1985 showed that the single depths at each station did not represent the entire warmwater habitat. The Assessment Unit has subsequently began to develop a more intensive index program, initially in the Kingston Basin, and currently expanding into the Central Basin. Two years of data are now available for the Kingston basin, and they are described elsewhere in this report (Mathers 1988).

Another index gillnetting program, targeted at salmonids during their spring movement to the inshore waters, was conducted by the Assessment Unit at a single location in the Western Basin between 1975 and 1984. This program, however, suffered from inconsistent gear use. It should also be noted that the catches represented highly specific and unusual circumstances (early spring, depths less than 4 metres).

During the International Field Year for the Great Lakes (IFYGL) the fisheries agencies around the lake collected information from gears and habitats that are not sampled on a regular basis. The additional gears included beach seines and trapnets in the nearshore zone, and midwater trawl in the offshore zone. I have not yet pursued the analysis of the beach seine and trapnet data. The midwater trawls were catching largely alewife and smelt. Only five other species were caught and their numbers were very low.

The United States agencies on Lake Ontario - the U.S. Fish and Wildlife Service and the New York Department of Environmental Conservation are also involved in major fisheries programs; many of them are cooperative between the two U.S. agencies, and some also involve the OMNR (adult lake trout, and to lesser degree alewife and smelt). The forage species are assessed in individual bottom trawling programs, one for each of alewife, rainbow smelt and the sculpins. The lake trout are assessed in two programs: juvenile fish with bottom trawls and mature fish with bot-

tom gillnets. These programs have been conducted on a regular basis for almost a decade, and more recently, a bottom trawl search for lake trout carcasses has been added. Additionally, NYDEC conducts a yearly warmwater gill netting survey in the eastern part of the lake, and USFWS has a bottom trawl program targeted at yellow perch in the same area.

The forage and lake trout programs conducted by USFWS/NYDEC are characterized by the way that they target on the species in question, both in time and in depth. They are also stratified in different ways to optimize the precision of the estimates. Any given program may therefore yield biased information on species other than the one with which it is concerned. This implies that a separate program would have to be conducted for each species of interest, and that information on all other species suffers.

The foregoing overview of the fisheries programs describes the state of data collection on Lake Ontario. It can be characterized by the following three points:

A We have non-specific programs of low intensity and of limited time and space coverage. These program do not adequately represent the fish communities of the lake because of the time or space restrictions, and possibly also because of limits imposed by the fishing gear.

B We have specialized assessment programs targeted at individual species. These programs are, again, not a suitable source of information on species for which they have not been intended.

C We have no source of information on large segments of the fish community (e.g. salmonines other than lake trout, or the littoral assemblages).

PROGAM PROPOSAL FOR 1988

In the four field seasons of COLA we propose to address the gaps in our knowledge that prevent us from immediately designing a community sampling program for the lake. The following major points have been identified:

1 SPATIAL DISTRIBUTION OF FISH - our knowledge of fish distributions varies with habitat. The pelagic zone in particular is not well known due to our limited experience.

2 FISHING GEAR - bottom trawls and bottom-set gillnets are the two well known gears, and they are currently used to sample the cold- and warm-water bottom assemblages. We have little experience with sampling the pelagic or the littoral fishes.

3 STATISTICAL ISSUES - the variability of catches has till now been side-stepped and most programs have not been designed to fullfil given precision criteria or, alternatively, they have not identified the precision of the resulting estimates. The variabilities inherent in the sampling process should be identified in order to develop more statistically rigorous programs.

The program proposed for 1988 has been designed to tackle issues 1 and 2 above. Three weeks at the beginning of the summer will be devoted to preparatory cruises concerned with solving the practical problems of sampling, gaining experience with the new vessel, and charting the bottom types in the Central Basin. The main program was originally specified as follows:

> DISTRIBUTION OF THE FISHES IN THE OFFSHORE ZONE, AND IDENTIFICATION OF SUITABLE SAMPLING METHODS: The main area of interest is the pelagic zone, but the bottom zone has been included because it is logistically easy to do so, and because of the likely movement of fishes between the two habitats. The offshore zone here is defined as the waters deeper than 50 metres. We want to concentrate on this zone in order to restrict our survey to the water column that encompasses the complete hypo-, meta- and hyperlimnion, and leave the shallower waters to be investigated later. In this project we will sample 8 stations with bottom and midwater gillnets, and bottom and midwater trawls during both day and night. Temperature measurements and acoustic assessment of the fish distribution will also be taken to supplement the information from the physical captures. All sampling at a given station will be performed within the shortest possible time (2 days or less). The results will be used to describe the spatial and temporal (diurnal) distribution of the fish in the offshore zone, and to identify the best times and methods for assessing them.

A very recent change in COLA field schedule, however, has brought about the possibility of extending this program, and at the time of writing it is has not been decided on how to proceed. The two main possibilities are a) staying in the offshore zone, boost the number of stations, and emphasize the gear comparison aspect of the project, or b) expand the project into the inshore zone to describe the fish destribution there as well.

Great Lakes Fishery Commission
Lake Ontario Committee Meeting
Gananoque, Ontario
March 8-9, 1988

RESEARCH ACTIVITIES OF LAKE ONTARIO FISHERIES UNIT

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1. Bay of Quinte Gillnet and Trawl Series (D. A. Hurley)

This series began in 1958 with an experimental gillnet set at one location (Hay Bay). The program expanded in 1972 and subsequent years to cover the entire bay. Bottom trawl drags were also begun in 1972 at several sites in the bay as an additional source of data especially for those species and sizes that were not vulnerable to the gillnets.

i) Gillnet

As part of the continuing program of monitoring the fish populations, experimental gillnets were set at locations in the upper, middle, and lower sections of the bay.

Overnight sets of standard gillnets (25 yards of each of 1, 1/2, 2, 2 1/2 inch mesh and 50 yards of each of 3, 3 1/2, 4, 4 1/2, 5 inch mesh tied as one gang) were made at three locations in the bay each month from May through August. This series has continued at varying levels of intensity since 1958. It has provided an invaluable data set by which changes in the fish community of the bay can be measured.

Values for the past few years are given in Table 1 which reports the arithmetic mean catch-per-unit-effort (CUE) prorated for 100 yards of each mesh size over the four sampling months.

The general trends observed in the 1987 data are: the continuing relatively low abundance of alewife at all sites but especially in the upper bay (Big Bay); the slight increase in white perch numbers; the increase in brown bullhead, channel catfish, and walleye in the upper bay; and the general constancy of abundance for other species listed.

TABLE 1. Mean catch per standard gillnet lift in the Bay of Quinte.

Species	Big Bay				Hay Bay				Conway			
	1984	1985*	1986	1987	1984	1985	1986	1987	1984	1985	1986	1987
Longnose gar	7.4		0	41.5	0	0	0	0	0		4.5	0
Alewife	1793.4		422.5	178.0	1927.0	2729.0	249.0	191.5	2721.0		808.0	741.0
Gizzard shad	15.4		10.5	22.5	4.5	1.0	2.5	2.5	1.0		0.5	0
Bullhead	21.5		43.0	62.0	22.5	15.0	45.5	16.5	0		1.0	0
Channel catfish	6.3		14.5	31.0	0	0	1.5	0	0		0	0
White sucker	30.1		29.0	26.5	23.5	25.5	7.0	23.5	35.5		50.5	127.0
Northern pike	5.2		5.0	5.0	3.5	4.5	1.0	5.5	0		0.5	0
Pumpkinseed	3.3		0.5	0.5	0	0	1.0	0.5	0		1.5	0
Smallmouth bass	17.6		6.0	2.0	14.0	21.5	7.5	4.0	1.5		4.0	1.0
White perch	371.9		482.0	713.0	104.0	55.0	99.5	83.5	22.0		59.0	70.5
Yellow perch	109.3		163.5	123.0	778.5	325.5	478.0	300.5	1141.0		1189.0	949.0
Walleye	82.0		35.0	110.0	43.5	49.0	49.5	13.5	4.0		78.5	23.5
Freshwater drum	61.8		32.5	35.0	12.0	8.5	23.5	7.0	0.5		1.0	0

*No fishing in 1985

TABLE 2. Mean catch per 0.25 mile trawl in the Bay of Quinte.

Species	Big Bay				Hay Bay				Conway			
	1984	1985	1986	1987	1984	1985	1986	1987	1984	1985	1986	1987
Alewife	493.8	30.0	18.6	55.6	181.0	440.0	289.6	298.8	639.0	5173.0	320.2	438.0
Gizzard shad	11.0	247.3	1.0	114.8	0	193.5	0.6	25.4	0	0	0.2	0
Smelt	0.2	2.5	0	0	102.6	139.5	197.0	3.8	122.4	2024.0	497.8	296.6
Trout-perch	17.8	15.8	18.0	7.0	0.4	16.8	39.6	129.8	5.4	12.0	98.0	198.8
Brown bullhead	0.8	3.3	9.4	4.0	0	11.0	2.0	5.0	0	0	0	0
White perch	17.8	18.0	44.2	186.6	0.6	81.0	51.6	23.8	0.6	0	10.6	6.6
Yellow perch	2.0	7.5	9.8	5.0	3.8	20.5	13.6	53.4	0.8	0.5	32.0	44.4
Walleye	1.4	6.5	17.0	6.8	2.8	8.5	9.8	14.0	0.2	0	12.4	12.8

The continued relatively low numbers of alewife in the upper bay may reflect the predation pressure they are exposed to from the large walleye population.

ii) Bottom Trawl

Bottom trawl drags were conducted at three sites in the bay that have been sampled since 1972 using a 3/4 "Western" polypropylene trawl over a 1/4 mile distance. Mean catches over the period May through September are listed for the past four years in Table 2.

Features to be noted are the low abundance of alewife in the upper bay, the high variable abundance of gizzard shad at Big Bay and Hay Bay, the lower abundance of rainbow smelt at Hay Bay and in the lower bay at Conway, the increased numbers of trout-perch at Hay Bay and Conway, and the increase in numbers of white perch in the upper bay. Yellow perch showed some increase in Hay Bay in 1987 and at Conway over the past two years. Walleye abundance did not change appreciably in 1987; however, the numbers of young-of-the-year (YOY) were not as high as in 1986 (Table 3). It is curious that YOY walleye continue to be taken in substantial numbers in the lower bay where in years previous to 1986 they were not generally present.

2. Trophic Studies (D. A. Hurley)

The current and timely debate over the relative influences of producer-controlled vs. consumer-controlled forces on the biomass and size composition of the major trophic levels in aquatic ecosystems has practical application in both water quality and fisheries management. Data acquired during Project Quinte (1972-1985) and collected in subsequent years on a reduced scale is proving invaluable in helping to further our insights into the mechanisms that operate in a large system.

A joint OMNR-OME report was released in November, 1987 that addresses the relative role of fish and phosphorus in controlling algae levels in the bay. A summary of that report is included here.

Recent changes in the phytoplankton of the Bay of Quinte: the relative importance of fish and phosphorus, November 1987. K. H. Nicholls and D. A. Hurley.

The effects of eutrophication control in the Bay of Quinte of Lake Ontario, resulting from a 50% reduction in phosphorus loading from municipal wastewater treatment plants in late 1977, have been examined. A major decline in phytoplankton biomass was observed in the highly eutrophic upper bay in 1978. However, in recent years (1982-1985), average May-October phytoplankton biomass increased to levels approaching those of the pre-phosphorus control period, but decreased again during 1986. No major shifts in phytoplankton composition occurred; domination by the diatoms Melosira and Stephanodiscus spp.

TABLE 3. Mean number of age 0 walleye per hectare from bottom trawl drags in the Bay of Quinte, May - October.

Year	Location		
	Big Bay	Hay Bay	Conway
1987	5.7	13.9	15.5
1986	49.5	21.2	22.8
1985	17.8	18.8	0
1984	1.6	5.0	0
1983	2.5	2.5	4.4
1982	32.7	0	0
1981	5.5	1.5	0.8
1980	0	0	0
1979	0	3.4	0
1978	29.4	12.2	0
1977	0	0	0
1976	0	0	0
1975	0	0	0
1974	0	0	0
1973	0	0	0
1972	0	0	0

and the blue-green algae Anabaena and Aphanizomenon spp. has continued. Although N-to-P ratios increased significantly from an average of 11.0:1 during the pre-P control period to 17-20:1 during 1985-1986 in the upper bay, no decrease was found in the proportion of the total phytoplankton contributed by N-fixing blue-green algae.

Phosphorus loading and phosphorus concentrations in the upper bay remained low, relative to the pre-1978 values. No significant correlations existed between total P and total phytoplankton biomass at the upper and middle bay sampling stations, either before or after phosphorus loading reductions; in part, this is because the phytoplankton was often N-limited before 1978. Highly significant positive correlation coefficients ($r = 0.90-0.96$) were found for phytoplankton-planktivorous fish relationships during both pre- and post phosphorus removal periods. A die-off of white perch (Morone americana) in the Bay of Quinte occurred during the winter of 1977-78. This was followed by several strong walleye (Stizostedion vitreum) year-classes, which have apparently since kept white perch numbers low. Between 1981 and 1985, alewife (Alosa pseudoharengus) numbers increased dramatically, but declined again in 1986. It is hypothesized that the combined densities of small sized white perch and alewife have contributed to altered grazing rates on phytoplankton by zooplankton and/or zoobenthos, and have been an important influence on phytoplankton biomass in the upper Bay of Quinte during the period 1972-1986.

Additional analysis of these data in preparation for journal publication has shown that the macrobenthic community, at least in the eutrophic upper Bay of Quinte, may be playing a much greater role in controlling phytoplankton biomass than the zooplankton. The effect of phosphorus concentration and environmental variables such as Trent River flow and mean monthly water temperatures enter the multiple regression significantly.. The regression of phytoplankton biomass as the dependent variable and values for the phosphorus equivalent concentration, measured as (N/10 + P), biomass of the major fish species, mean monthly temperatures, and mean monthly flow of the Trent River as independent variables produced a highly significant fit (Fig.1) (overall $P<0.0003$, $F = 16.69$, on 8,15 df, $R^2 = 0.94$). Benthivorous white perch was the only species that entered the regression significantly. White perch consume large numbers of chironomids larvae which have been shown to feed heavily on the diatom Melosira, which is the dominant phytoplankton species in the bay. The regression that best describes the phytoplankton data is:

$$PH=1.437MT-2.641JT+1.605AT+0.060WP+0.088JF-0.126AF+0.054P+6.789$$

where PH is the phytoplankton biomass in the Belleville area in mm3/L, MT, JT, and AT are the mean monthly water temperatures in May, July, and August, respectively, JF, AF are the mean monthly Trent River flows in m3/sec for July and August, respectively, WP is the geometric mean biomass of white perch from monthly bottom trawls in May through September in kg/ha, and P is the concentration of phosphorus equivalents in the upper bay as micrograms/L. The t-test for the independent vari-

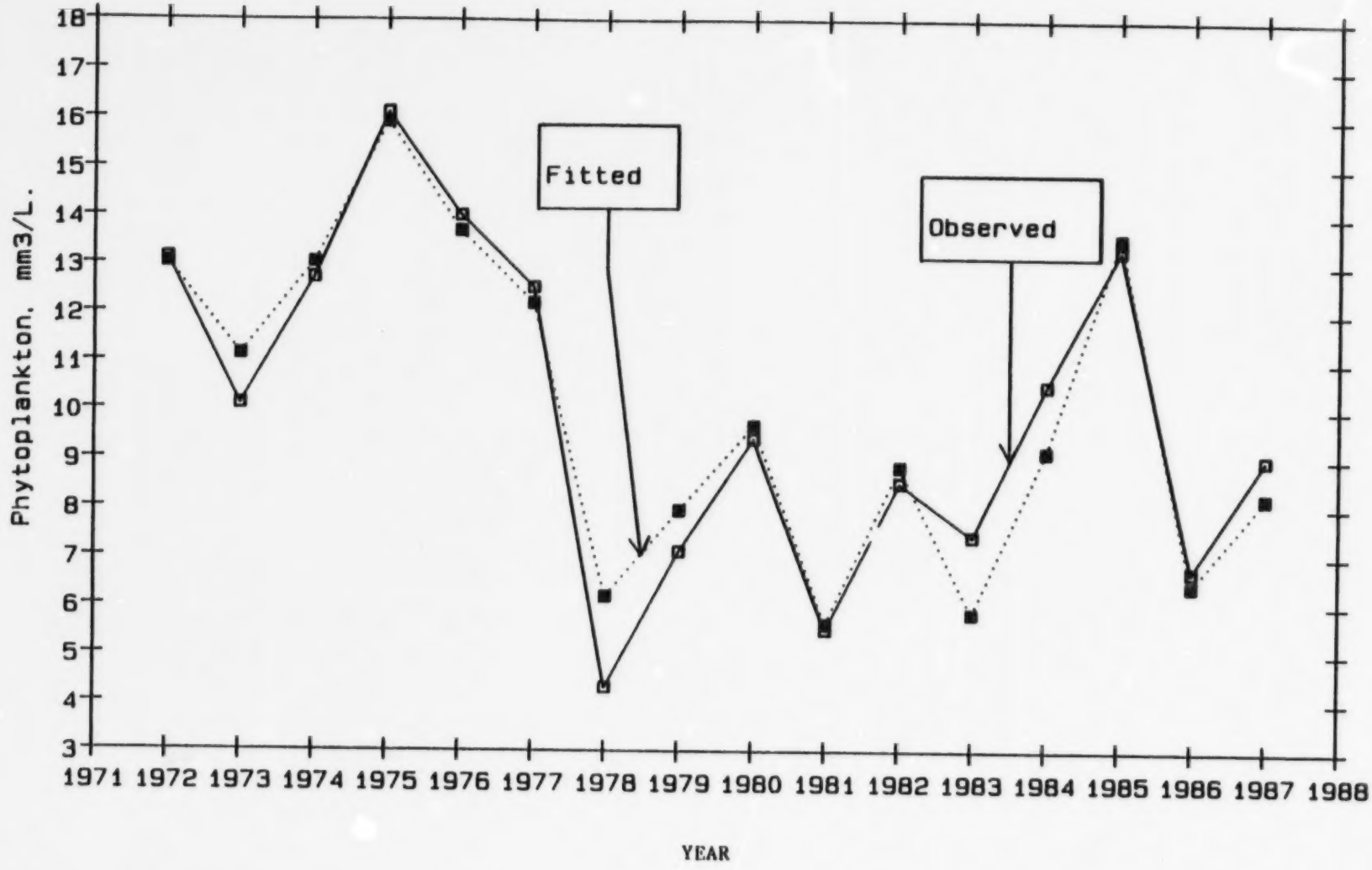

FIG. 1. Observed and fitted values for phytoplankton abundance in the upper Bay of Quinte.

ables showed they were all significant. Other statistical tests failed to show any significant autocorrelation between the independent variables. Plots of residuals showed they were normally distributed.

It is of interest that the benthivorous white perch and not the planktivorous alewife were involved significantly in the phytoplankton regression. Although small white perch, under 100 mm fork length are largely planktivorous, as are the small sizes of other species, there does not appear to be any significant alteration in the zooplankton community that has resulted from changes in the fish community. The influence of zooplankton abundance as a major factor in controlling phytoplankton in the upper bay appears not be as important as previously thought. The bay continues to be dominated by small size cladocerans that are relatively inefficient in cropping the dominant algal forms.

The role of trophic interactions in determining water quality is much greater than had been previously suspected. As much as 80-85% of the changes in phytoplankton abundance in the bay can be ascribed to environmental variables of temperature and water flow and fish (food-chain effects), and only 15-20% to phosphorus concentration reductions. There is ample reason, therefore, to consider that fish management and water quality management are intimately linked and must be examined together in any rehabilitation program.

3. Fish Species Studies (D. A. Hurley and M. S. Ridgway)

a) White Perch

WHITE PERCH IN THE BAY OF QUINTE: 35 YEARS AFTER THEIR INVASION

An extensive data base exists on the invasion and subsequent explosive increase in the abundance of this species in the Bay of Quinte. Certain aspects of the biology of this species are now being analyzed with the aim of publishing the results in the near future.

Among the topics being investigated are year-class variations, growth rate changes, total mortality estimates, and fecundity changes. These features together with cyclic patterns in climatic variables can be fitted together to produce a reasonable picture of the invasion ecology of this species in the Bay of Quinte.

Estimates of young-of-the-year white perch biomass as given by bottom trawl drags can be modeled using July and August mean water temperatures ($P = 0.001$, $F = 20.7$ on 2, 12 df, $R^2 = 0.775$). Additional data, such as spawning stock size and water levels, did not enter the regression significantly. The role of water temperature in regulating YOY abundance corroborates earlier studies on this species.

A model of year-class strength for white perch was constructed using overwinter water temperatures, May and June water levels and July and October thermal sums ($P = 0.0001$, $F = 13.5$ on 6, 20 df, $R^2 = 0.802$). Again, the size of the spawning stock did not enter the regression significantly.

The conclusion from these data is that environmental factors of water level and temperature are the primary determinants of year-class strength among white perch in the bay.

b) Alewife (M. S. Ridgway)

TEMPERATURE, PREDATION AND THE BIOMASS OF ALEWIFE IN THE BAY OF QUINTE, LAKE ONTARIO

The purpose of this study was to examine the relative roles of winter temperatures and predation in determining the biomass of alewife in the Bay of Quinte. Alewife biomass (kg/ha) was monitored with a bottom trawl survey from 1972 to 1987. The estimates were limited to samples taken in June and July. Total biomass was high in all areas of the bay prior to 1977 (approx. 30-40 kg/ha) and declined throughout the bay following unusually cold winters in 1976-77 and 1977-78 (approx. 3-4 kg/ha). Beginning in 1980, a recovery of total biomass following this perturbation was observed in the lower bay, adjacent to Lake Ontario, but not in the upper bay where predation by a resurgent walleye population has maintained a reduced level of alewife biomass.

Since 1980, alewife biomass in the upper bay has been approximately 1 kg/ha or less. This low level indicates that alewife consumption by walleye has often exceeded the biomass of alewife available under most scenarios describing walleye abundance (Hurley 1986). It is not surprising, then, that walleye abundance has recently increased in the lower bay. It remains to be determined if this increase in walleye abundance will result in a decrease in alewife biomass in the lower bay. The 1987 data are suggestive; alewife biomass in the lower bay was as low as the levels observed after the winter kill of the late 1970s.

I conclude that walleye predation has played an important role in generating differences in alewife biomass between the upper and lower bay areas since 1980. Recent changes in walleye abundance in the lower bay may be creating a second "natural experiment" that should be monitored. If alewife biomass declines in the lower bay then this would further support the important of predation as a mechanism governing alewife abundance in the Bay of Quinte.

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4. Lake Ontario Studies (J. M. Casselman and D. A. Hurley)

a) Ongoing Sampling

i) Gillnet

The purpose of this ongoing sampling project is to assess and study the community dynamics of the fishes of the outlet basin (Kingston Basin) of Lake Ontario. The sampling involves bottom-set experimental gillnets and bottom trawling, and encompasses a 27-year period from 1961 to 1987. The gillnet sampling has been conducted in 26 of the past 27 years (excluding 1965). Trawling has been conducted for 16 years, starting in 1972. Sampling is conducted at six fixed sampling sites that are from 26 to 29 m deep. The sites are sampled once each month for the three midsummer months of June, July, and August. The gillnets are a standard experimental gang composed of 25 yd of 1.5 inch and 25 yd of 2.0-inch mesh, and 100 yd each of 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0 inch mesh connected to form one continuous gang. The catch per unit effort is expressed as numbers pro-rated to represent the catch for 100 yd of each of the eight meshes. These nets have a hanging ratio similar to that used on Lake Ontario commercial whitefish nets. Bottom trawling is conducted with a similar sampling schedule at each of these six gillnet sites. Bottom tows are made for a distance of 0.5 miles at a speed of approximately 3 miles per hour, using a 3/4 "Yankee Standard" No. 35 trawl. The catch per unit effort is expressed as the average number caught per mile. For present purposes, catch data are averaged for the three months--June, July, and August.

Gillnet catches over the years have shown some rather distinctive trends. Most obvious is the catch of lake trout, which remained high and even increased slightly in 1987 (Table 4). The catches of lake whitefish show a similar increasing trend with an obvious increase in 1987. The lake herring catches remained low but are possibly increasing slightly. The catch of yellow perch has shown a prominent decrease in recent years. The total catch of smelt and alewife remains high. However when these catches are separated by fish size it is apparent that there has been a prominent decrease in the catch of large smelt. Fewer large alewife are also being caught (Casselman, Christie, and Scott, unpublished).

TABLE 4. Average catch by species per standard gillnet lift in the Outlet basin of Lake Ontario, 1961 to 1987. Results are averaged for six stations sampled once in each of three months - June, July, and August. The catches are for a net composed of 100 yards each of eight mesh sizes: 1 1/2 to 5 inch, in 1/2 inch intervals.

Year	Alewife	Smelt	Yellow perch	Lake herring	Lake whitefish	Trout[a]
1961	147	147	7		3.1	0.03
1962	141	83	22		2.4	0.07
1963	228	141	5	0.3	2.0	0.09
1964	20	161	-	0.3	0.3	0.42
1966	1306	253	28	0.8	0.8	0.00
1967	245	132	12	0.2	0.7	0.00
1968	110	222	18	0.5	1.5	0.00
1969	599	217	26	0.8	0.8	0.00
1970	1089	232	38	1.1	0.9	0.00
1971	349	208	20	0.8	1.2	0.00
1972	51	480	14	0.9	0.6	0.00
1973	125	197	23	0.7	0.5	0.00
1974	2121	312	56	1.1	0.3	0.00
1975	587	379	21	1.1	0.8	0.88
1976	757	263	8	0.9	0.6	0.25
1977	46	212	23	0.7	0.6	0.92
1978	84	335	59	0.8	0.5	2.75
1979	146	363	16	0.8	0.4	3.08
1980	189	343	29	0.4	0.5	6.50
1981	585	307	71	1.3	1.8	3.00
1982	872	231	35	0.9	3.5	6.00
1983[b]	359	200	16	0.5	3.8	9.92
1984[c]	83	158	1	2.6	5.0	10.33
1985	976	151	10	1.0	3.0	17.50
1986	741	116	4	1.4	9.1	11.67
1987	987	203	1	2.0	12.2	13.50
Avg	498	223	23	0.9	2.2	3.34

[a]Data on lake trout - only one month (July) and only one mesh size (4½ inch) used.

[b]July, August cruises only.

[c]August cruise only.

Catches in bottom trawls over the years in some cases have corroborated trends in gillnets and in other cases have provided an inverse relationship. These differences, however, can usually be explained by the fact that the trawls generally sample smaller younger individuals. In recent years the catch of alewife in the trawls appears to be decreasing (Table 5). The catch of smelt, although high in recent years, may be decreasing somewhat. The catch of slimy sculpin may also be decreasing somewhat. However, the numbers of trout-perch and Johnny darters taken in trawls are approximately the same in recent years.

Before the relative significance of these trends can be fully evaluated, the observational variability of these two sampling gears must be evaluated. Research proposes to study this variability and conduct a detailed analysis of this long-term data series.

TABLE 5. Average catch by species per standard 1-mile bottom trawl in the Outlet basin of Lake Ontario, 1972 to 1987. Results are averaged for six stations sampled once in each of three months - June, July, and August. The trawl is a 3/4 "Yankee Standard" No. 35. The trawl has a 1/2 inch cod-end mesh. However, from 1977 to 1982 and 1984 to 1987 a 1/8 inch mesh liner was used.

Year	Alewife	Smelt	Sculpin	Trout-perch	Johnny darter
1972[a]	214.0	1200.6	225.4	13.4	0.3
1973	308.0	2013.7	460.3	25.7	1.0
1974	3519.8	1480.7	122.4	44.8	0.1
1975	730.9	1777.4	137.0	27.1	0.7
1976	1255.3	1425.2	119.3	29.8	0.7
1977	74.3	1220.8	106.8	19.1	1.6
1978	691.2	2117.5	113.0	233.6	2.1
1979	143.6	2420.8	138.9	196.7	2.0
1980	488.8	3004.7	164.7	120.6	1.4
1981	1306.7	3539.7	149.8	86.4	3.0
1982	1052.6	3088.7	62.3	17.3	2.8
1983[b]	408.0	4102.8	95.3	346.3	0.7
1984[b]	321.5	2366.8	51.8	105.3	0.8
1985	2470.9	5995.9	112.3	87.7	4.0
1986	209.9	2934.7	131.4	31.7	1.1
1987	188.4	2761.1	98.4	91.2	2.0
Average	836.5	2590.7	143.0	92.3	1.5

[a]July only.

[b]July and August only.

5. Bay of Quinte Remedial Action Plan (D. A. Hurley)

The purpose of the Quinte RAP, as it is for all other RAPs, is to define the necessary actions and an appropriate timetable to restore the beneficial uses of the Bay of Quinte through implementation of programs to control environmental problems. Steady progress has been made on preparing the draft document and a timetable has been set that gives dates for the completion of various steps in the process. A public review of the draft RAP will begin by November, 1988 at which time discussion of the options for remedial action on specific concerns will occur. Transmittal of the final RAP to the Water Quality Board is scheduled for March, 1989.

It is recognized that the solutions to many of the continuing eutrophication problems in the bay are not currently known and that a considerable research component will have to be built into the RAP. Fisheries studies are required as a part of the development of a habitat map of the bay. There is also a need to increase our understanding of the influence of the nearshore shallow water zones on the productivity of the bay and how the various sectors of the bay are influenced by alterations in the physical habitat. Until such data are available there will be shortfalls in our ability to provide effective remedial actions. These deficiencies will be highlighted in the final report with recommendations that future research needs be addressed.

6. Alewife Diet And Feeding Ecology In The Bay of Quinte, 1975—1986 (R.H. Strus)

CONCLUSIONS

1. Bay of Quinte alewife do consume crustacean zooplankton species similar to those sampled during concurrent zooplankton community studies. Moreover, the relative abundances of broad zooplankton groupings generally reflected those of the resident community, indicating that, within the resolution of these groups, the entire zooplankton community was being utilized.

2. Within a finer taxonomic context, the dominant zooplankton species within the upper bay were also being utilized, although Bosmina to a lesser extent than the others. Preference for large and/or opaque plankters did occur frequently but affected overall composition strongly in only a few instances.

3. Bay of Quinte alewife were occasionally benthivorous during times of both high and low zooplankton densities, although bottom fauna never constituted an important food supply.

4. Little evidence exists for a switch to non-selective filter feeding during high daytime zooplankton densities.

INTRODUCTION

The ongoing monitoring and study of the Bay of Quinte ecosystem has included the collection of alewife (Glenora Fisheries Research data) and crustacean zooplankton (Great Lakes Fisheries Research data) since 1975. As alewife are primarily zooplanktivorous fish, study of the interrelationships between these two levels of the pelagic food chain was made possible by combining the two data sets, for a more detailed examination than made previously (Hurley, 1986). The characterization of alewife feeding habits within the upper and lower bay areas and their associated feeding preferences in relation to the resident zooplankton community were the major areas of interest. Additionally, knowledge of the degree of utilization of various taxonomic groups within the zooplankton community by alewife did not previously exist.

Analysis (identification and enumeration) of stomach contents from bottom-trawled Bay of Quinte alewife has been completed for the years 1975 to 1980 and 1984 to 1986. Samples from upper and lower bay locations were characterized according to species composition and corresponding times and locations whenever possible.

Related literature (Wells, 1968; Hutchinson 1971; Jansen and Brandt 1979; Brandt, 1980; Argyle, 1982) on lacustrine alewife depth distribution patterns states that the fish may be found in, and migrating between, pelagic and bottom-water habitats, by day or night. Zoopankton populations within the water column of the deeper, stratified lower bay vary with respect to their species composition and density. Consequently, problems exist in relating resident zooplankton and associated alewife stomach contents at this location. As a result, detailed comparisons have been restricted to the shallower (3-4 m.) non-stratified upper bay, where the liklihood of more uniform interaction is greater. To date, upper bay alewife stomachs (Big Bay-Belleville area) from 1975-76, 1979-80 and 1985-86 have been characterized and compared to the resident zooplankton communities in terms of species composition.

METHODS

Alewife and crustacean zooplankton field and lab methodology is described in Cooley et al. 1986 and Hurley 1986. Zooplankton data were treated so that all depth strata sampled were equally represented, rather than surface weighted according to basin morphometry, when combined to generate mean values for the entire water column.

Alewife stomach contents were identified and enumerated to species whenever possible and usually subsampled for a total count of approximately 200 organisms. If less than 200 individuals existed, the entire sample was counted. Counts from each sampling date and location were combined to generate mean values per alewife. The closest available zooplankton sampling date (within several days) from the same area or station (eg. Big Bay-Belleville) was used for comparison to the alewife data. If the alewife sampling date fell in between two zooplankton sam-

plings the mean value of the two was calculated. Species composition, of an annual and daily bais, was described in terms of percent numerical contribution to the total stomach contents.

Preference indices used were those of Ivlev, and Vanderploeg and Scavia (Lechowicz 1982). Ivlev's electivity index (E_i),

$$E_i = \frac{(r_i - p_i)}{(r_i + p_i)}$$

(where r_i and p_i represent the proportion of food in the diet and in the environment, respectively), was found to generate identical preference rankings to those of Vanderploeg and Scavia's selectivity coefficient E_i (as did Lechowicz 1982).

$$E_i^* = \frac{[w_i - (1/n)]}{[w_i + (1/n)]}$$

where n = the numbers of kinds of food items and,

$$Wi = \frac{r_i/p_i}{\leq_i r_i/p_i}$$

Paloheimo (1979) stated that, unless variables such as density of prey, volume of environment searched by predator per unit time in relation to prey i, probability of capture of prey i once sighted and, delay and handling time are taken into account, all measures of prey preference were relative rather than absolute. As the use of index values to calculate absolute preferences can be misleading, the most meaningful and useful observation when interpreting preference index values (Lechowicz 1982) is that of ranking the various food items utilized.

RESULTS

Alewife stomach contents were composed mainly of micro-crustacean zooplankton. Cladocera, followed by cyclopoid copepods were generally the most abundant groups, while calanoid copepods were least well represented. This ranking of the three major crustacean groups also exists in the relative abundances of Upper Bay zooplankton, although a few exceptions exist (Table 6). Within the resolution of these broad groupings, alewife seem to be utilizing what is present in the zooplankton community (Fig. 2). Occasionally, cyclopoid copepods did contribute a much greater proportion in alewife stomachs than in the environment, indicating feeding preference. Since cyclopoids and cladocera usually comprise most of the organisms ingested in the upper bay, the relation between their relative abundances is reciprocal.

Although comparisons in the lower bay are difficult to make as a result of variation in the vertical distribution of the zooplankton community, it is known that lower bay cyclopoid copepods compose a larger

Table 6. Crustacean zooplankton order and suborder abundance (% contribution) in Upper Bay zooplankton community and in concurrently sampled alewife stomach contents.

Sampling Date	Cladocera		Copepoda: Cyclopoids		Copepoda: Calanoids	
	zooplankton	alewife	zooplankton	alewife	zooplankton	alewife
June 26/75	76.0	10.5	23.6	88.6	0.3	0.1
July 28/75	94.0	95.1	5.2	4.4	0.8	0.0
Aug. 18/75	69.2	76.1	30.3	21.5	0.5	1.8
Oct. 3/75	63.4	36.5	34.6	60.6	2.0	0.05
May 21/76	59.8	69.0	39.7	30.8	0.4	0.0
June 17/76	95.3	64.1	4.2	35.3	0.5	0.4
July 30/76	78.6	31.9	21.0	67.9	0.3	0.2
Aug. 25/76	78.1	77.5	21.7	22.2	0.2	0.1
Sept. 21/76	63.4	92.4	35.3	7.2	1.2	0.1
June 29/79	93.3	96.0	6.1	3.7	0.5	0.1
July 26/79	91.3	84.8	8.1	15.1	0.5	0.05
Aug. 23/79	77.5	93.0	19.5	6.6	3.0	0.2
Sept. 18/79	82.5	91.3	16.7	8.2	0.7	0.3
June 20/80	84.9	81.6	14.5	14.7	0.6	3.5
July 17/80	90.2	74.0	15.3	25.9	1.0	0.1
Aug. 21/80	90.2	84.6	9.7	15.5	0.0	0.05
Oct. 2/80	81.2	89.0	18.6	10.9	0.1	0.05
June 19/80	79.8	79.2	16.3	20.1	3.5	0.1
Aug. 20/80	75.5	81.1	24.0	16.4	0.5	0.2
Oct. 6/80	84.0	63.1	15.9	37.0	0.1	0.1
June 19/85	89.0	89.3	9.5	9.5	1.4	1.0
July 22/85	81.2	26.4	18.7	21.7	0.1	0.5
Sept. 18/85	82.3	66.0	17.4	33.9	0.3	0.0
June 25/86	83.7	70.3	8.8	26.7	7.5	1.8
Aug. 15/86	90.9	46.2	8.8	52.8	0.3	0.8
Aug. 21/80	90.2	56.0	9.7	42.1	0.0	0.9
Oct. 2/80	81.3	79.5	18.6	20.1	0.1	0.0

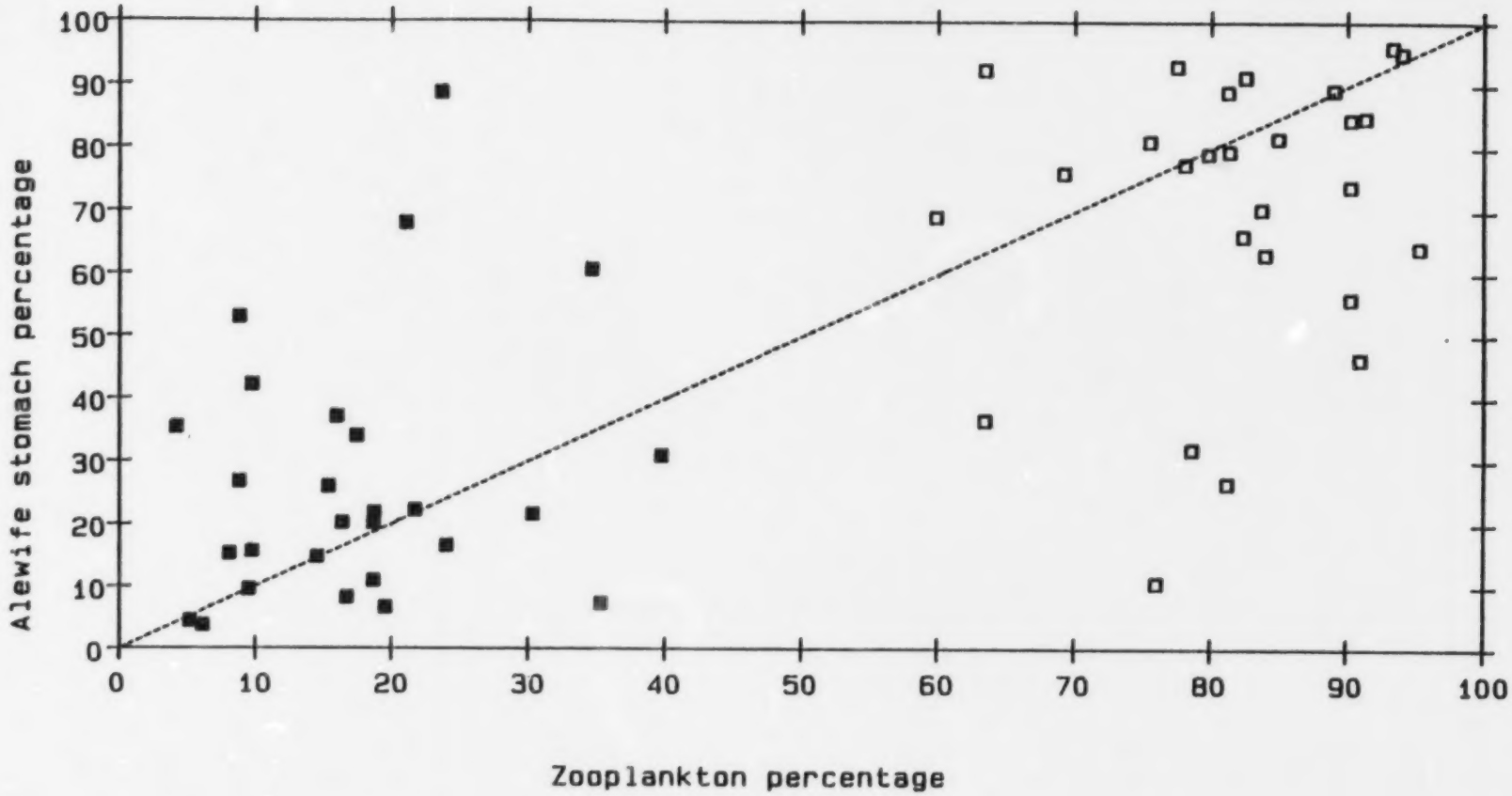

FIGURE 2. Percentage abundance of cladocera (open squares) and cyclopoid copepods (closed squares) in the upper Bay of Quinte zooplankton community and alewife stomach contents, 1975-1986.

proportion of the total plankton than in the upper bay (Cooley et al. 1986). An examination of the relative abundance of cyclopoids in alewife stomach contents generally shows a similar trend (Table 7) - in eighteen out of a total of twenty-one possible comparison dates, the proportion of cyclopoids is greater in the lower bay. Again, this adds evidence to the supposition that the alewife are generally consuming the larger groups of zooplankton in the proportion that they exist in the zooplankton community.

It is noteworthy that some organisms typical of the benthic community were occasionally ingested, such as chirononid and ceratopogonid larvae. These were never numerous enough to constitute an important food source. On one occasion, when zooplankton densities were low (Oct. 3, 1975), quantities of sediments were found along with ingested zooplankton and benthic organisms.

The dominant cladocera found in the Big Bay-Belleville area (Bosmina longirostris, Eubosmina coregoni, Chydorus sphaericus) (Cooley et al. 1986) are consumed by alewife although feeding preferences of these varied. Eubosmina and Chydorus were generally preferred to Bosmina as food items although a single exception to this exists (Table 8). While both bosminids are fairly similar in shape, the smaller size of Bosmina (approx. 0.3 mm. mean length versus approx. 0.4-0.5 mm. for Eubosmina) may have accounted for its overall lower preference by alewife. An even smaller plankter, Chydorus (mean length approx. 0.2 mm, also received a higher preference in most instances. Being highly pigmented (opaque) and spherical rather than flattened may have increased the visibility, and therefore the vulnerability of Chydorus to alewife predation when compared to Bosmina. On one occasion, (June, 1976), the Big Bay Bosmina population exploded, accounting for 75% of the total crustacean zooplankton. While all three species were present at the time, Bosmina was still the least abundant food item of the three. With the exception of Bosmina, cladoceran preferences were inconsistant between sampling dates, probably as a result of differences in the relative maturities and consequent sizes of the various species in question (Table 8).

Daphnia, a subdominant genus in Big Bay during 1975 and 1976, increased in abundance during 1979 and 1980. This was reflected in a correspondingly greater proportion being found in alewife stomachs during the latter years (Table 9). During 1980, 1985 and 1986 Daphnia galeata mendotae, (a larger species than the co-occuring D. retrocurva when mature) also became relatively more abundant in the upper bay than in previous years (Cooley et al. 1986). This zooplankter was also a preferred food item, usually being represented to a greater extent in alewife stomachs than in the environment (Table 9). Since Daphnia sp. have been documented to decompose more rapidly than other zooplankton in alewife stomachs (Gannon 1976) abundances and preferences of these are probably underestimates. Daphnia galeata mendotae can attain large sizes (up to 3.0 mm) and represents a potentially heavy grazer in the upper bay.

Table 7. Relative abundances of cyclopoid copepods (% contribution to total) in alewife stomachs in upper and lower Bay of Quinte, 1975-1986.

	Upper Bay (Big Bay, Belleville)	Lower Bay (Glenora, Conway, Lennox)
1975		
June 26	88.6	28.9
July 28	4.4	75.0
August 18	21.5	35.1
October 3	60.6	56.5
1976		
May 21	30.8	52.7
June 17	35.3	56.6
July 30	67.9	57.0
August 25	22.2	31.0
September 21	7.2	83.8
1979		
June 21	3.7	49.3
July 26	15.1	93.2
August 23	6.6	69.8
September 18	8.2	-
1980		
June 20	14.7	58.7
July 17	25.9	92.5
August 21	15.5	90.6
October 2	10.9	58.9
1984		
September 18	14.7	59.6
1985		
June 17	9.4	90.3
July 23	18.6	74.2
1986		
June 24	8.4	63.9
August 14	8.0	91.4

Table 8. Dominant zooplankton found in alewife stomachs and zooplankton community in the upper Bay of Quinte, ranked according to preference (1 = highest preference).

Sampling Date	Bosmina	Eubosmina	Chydorus	Daphnia Sp	Cyclopoids
1975 (Big Bay-Belleville)					
June 26	4	3	2	5	1
July 28	5	2	1	4	3
Aug. 18	5	3	1	4	2
Oct. 3	4	1	3	-	2
1976 (Big Bay-Belleville)					
May 21	5	1	2	3	4
June 17	5	2	4	3	1
July 30	5	3	2	4	1
Aug. 25	-	3	1	4	2
Sept. 21	-	2	1	4	3
1979 (Big Bay-Belleville)					
June 21	-	2	1	3	4
July 26	-	2	4	3	1
Aug. 23	-	1	2	3	4
Sept. 18	-	1	2	4	3
1980 (Belleville)					
June 20	-	3	4	1	2
July 17	5	2	3	4	1
Aug. 21	-	1	4	3	2
Oct. 2	4	2	1	-	3
1980 (Deseronto)					
June 19	-	1	3	4	2
Aug. 20	-	1	3	4	2
Oct. 6	-	1	3	-	2
1980 (Big Bay)					
Aug. 21	-	2	4	3	1
Oct. 2	4	2	1	-	3
1980 (Trenton)					
Aug. 21	-	1	2	4	3
1985 (Big Bay-Belleville)					
June 19	5	3	4	1	2
July 22	2	5	4	3	1
Sept. 18	5	3	4	1	2
1986 (Big Bay-Belleville)					
June 25	5	3	2	1	4
Aug. 15	5	3	4	2	1
Mean Rank	4.73	2.21	2.71	3.25	2.25

Table 9. Upper Bay (Big Bay-Belleville) Daphnia relative abundances, expressed as percent of total. Within each column, values to the right represent stomach contents, those on the left, the zooplankton community. Daphnia sp. within stomach contents are individuals mutilated as a result of being ingested and are difficult to speciate.

1975			June 26		July 28		Aug. 18		Oct. 03	
Daphnia sp.	-	-	-	0.4	-	0.5	-	1.0	-	0.9
D. g. mendotae	-	-	0.2	0.1	-	0.1	-	<0.1	0.1	-
D. retrocurva	-	-	6.9	0.2	2.8	0.3	3.6	1.0	-	-
Total %	-	-	7.1	0.7	2.8	0.9	3.6	2.0	0.1	0.9

1976	May 21		June 17		July 30		Aug. 25		Sept. 21	
Daphnia sp.	-	1.8	-	2.3	-	3.6	-	1.1	-	0.4
D. g. mendotae	<0.1	-	-	-	-	-	-	-	-	-
D. retrocurva	0.9	-	0.8	-	10.6	-	4.8	-	7.4	-
Total %	0.9	1.8	0.8	2.3	10.6	3.6	4.8	1.1	7.4	0.4

1979			June 21		July 26		Aug. 23		Sept. 18	
Daphnia sp.	-	-	-	4.3	-	16.7	-	5.2	-	-
D.g. mendotae	-	-	0.1	0.2	<0.1	0.1	0.4	-	-	-
D. retrocurva	-	-	14.1	4.9	33.8	18.0	21.9	4.7	5.7	-
Total %	-	-	14.2	9.4	33.8	34.8	22.3	9.9	5.7	0.0

1980			June 20		July 17		Aug. 21		Oct. 02	
Daphnia sp.	-	-	-	10.6	-	2.1	-	5.4	-	0.1
D. g. mendotae	-	-	2.6	5.2	0.6	0.4	-	-	-	-
D. retrocurva	-	-	14.6	11.6	9.9	0.9	10.6	8.9	0.6	<0.1
Total %	-	-	17.2	27.4	10.5	3.4	10.6	14.3	0.6	0.1

1985			June 19		July 22				Sept. 18	
Daphnia sp.	-	-	-	39.1	-	2.1	-	-	-	2.2
D. g. mendotae	-	-	1.8	21.9	0.2	0.2	-	-	0.6	3.0
D. retrocurva	-	-	12.6	4.4	5.5	4.4	-	-	1.5	1.0
Total %	-	-	14.4	65.4	5.7	6.7	-	-	2.1	6.2

1986			June 25		-	-	Aug. 15			
Daphnia sp.	-	-	-	27.0	-	-	-	16.8	-	-
D. g. mendotae	-	-	-	8.0	-	-	0.3	4.2	-	-
D. retrocurva	-	-	4.2	0.6	-	-	12.8	0.1	-	-
Total %	-	-	4.2	35.6	-	-	13.1	21.1	-	-

Adult cyclopoid copepods (Mesocyclops edax, Cyclops vernalis) were also generally preferred food items, probably due to their larger sizes and greater overall opacity. Consequently, cyclopoid copepods, as a group, were one of the most highly ranked food items for alewife (Table 8). Preference for large and/or more opaque zooplankton in visually orienting fish has also been documented elsewhere (Brooks and Dodson 1965, Brooks 1968, Zaret and Kerfoot 1975). As adult cyclopoid copepods are known to be predacious on smaller zooplankton (as are found in the upper bay), selective reduction of large cyclopoids may represent a mechanism further favouring the dominance of small cladocera in addition to that of alewife predation.

Smaller size and lesser opacity characterizes sub-adult stage copepodids. Consequently alewife feeding preferences were inconsistent and generally less pronounced, if preference occurred at all. Very small early instar copepods (nauplii) were rarely seen in alewife stomachs.

Calanoid copepods were only occasionally ingested by alewife, while at the same time their occurence was infrequent in the zooplankton community (Table 6). As a result of the small sample sizes encountered, no definite pattern is evident in alewife feeding behaviour.

DISCUSSION

As alewife are important vectors governing production in the transfer of energy from phytoplankton to large, predatory fish species within the Bay of Quinte, knowledge of alewife feeding habits provides insight into the interrelationships existing within various levels of the aquatic food chain. Being primarily zooplanktivorous fish, alewife convert secondary production within the bay ecosystem into a food source available to higher trophic levels that, in turn, are usable human resources. The degree of utilization of the zooplankton community as it exists in the pelagic environment adds to the information available describing the production mechanisms responsible for the continued presence of desirable fish species within the Bay of Quinte.

Alewife stomach contents in the upper Bay of Quinte consist of crustacean zooplankton species that are similar to those found in the zooplankton community. Proportions of orders and suborders (cladocera, cyclopoida, calanoida) usually reflect those of the existing zooplankton community as well. However, preference for large cyclopoids may occasionally result in their predominance in stomach contents. Comparison of alewife feeding patterns within the upper and lower bay also generally reflects the relative proportions of broad zooplankton groups as they are found in these areas. The dominant species of zooplankton seem to be utilized by the alewife populations sampled in the upper bay, except for Bosmina longirostris, which was underrepresented in stomachs. The reduced importance of Bosmina as a food resource may be a result of relative size and visibility preference. Small zooplankton (as small as 0.2 mm. in Chydorus sphaericus) are still a food resource for alewife, indicating that physical feeding limitations (such as gill

raker spacing, visual acuity, etc.) should not affect zooplankton above this size, of which Bosmina is an example. Additionally, the lower limit of food particle size available to alewife exists at some point less than the above.

Visually (particulate) feeding alewife typically feed facing upward, towards the surface (Janssen 1978). Particles suspended in the water column that are relatively large and opaque would present the most visible silhouette and would therefore be preferred food items. If these are readily available to alewife, it is logical that their feeding would result in a large proportion being present in their stomachs. The large numbers of small, relatively transparent plankters in Bay of Quinte alewife stomachs (and in the zooplankton community itself) suggests high levels of visual predation. It may be that larger plankters (such as Daphnia galeata mendotae, Daphnia pulex) do appear in the upper bay periodically, but are reduced or eliminated by predation quickly.

During high densities of zooplankton (>100,000/m) it has been suggested that alewife filter feed indiscriminately on the available plankters (Janssen 1976). Stomach contents of fish feeding only in this manner should closely resemble the species composition of the ambient zooplankton community. While most upper bay densities were higher than the above, there were many instances of high preference for certain taxa (eg. large adult copepods), which were repeatedly observed over time. Under-representation of high population densities of certain taxa has been found under these conditions as well. As a result, Bay of Quinte alewife, feeding during high daytime zooplankton densities, did not consume zooplankton in a mode consistant with that of non-selective filter feeding, but continued to exhibit preference for some portion of the available zooplankton.

Feeding habits of alewife, as determined in this study, reveals a small degree of benthic feeding. While by far the greater bulk of their food consisted of zooplankton, organisms were also found that were typical of bottom water habitats, during times of both low and high zooplankton abundances. As a result, alewife feeding behaviour cannot be described as solely planktivorous in the Bay of Quinte.

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7. **Lake Trout Spawning Study — Yorkshire Bar, 1987** (J. M. Casselman)

In the fall of 1987 a study was commenced to examine lake trout spawning in the outlet basin of Lake Ontario. The general purpose of the study is to obtain information concerning spawning and natural recruitment of lake trout stocks which are being rehabilitated in Lake Ontario. The specific goals are (1) to study spawning congregations that are developing around traditional spawning grounds, specifically Yorkshire Bar; (2) to compare the density and behaviour of these fish with other indigenous stocks and with other current and historical information from Lake Ontario; (3) to determine the spawning behaviour of these lake trout and establish if they are successfully depositing viable, fertilized eggs; and (4) to measure the density and location of these eggs in relation to the available substrate.

In conjunction with this study, a search is being conducted to determine if juvenile lake trout are emigrating from these spawning grounds and determine the location and environmental conditions of the nursery habitat of indigenous Lake Ontario lake trout.

Yorkshire Bar was chosen for this spawning study because it was a well-documented traditional spawning ground of native lake trout, and commercial fishermen who fished these spawning grounds at spawning time before the demise of nature stocks in the early 1940's have provided historical observations. From 1975 to 1984 Fisheries Research has sampled Yorkshire Bar at spawning time with experimental gillnets. This data set provides an opportunity to examine and evaluate the re-establishment of a spawning stock in the outlet basin of Lake Ontario and assess its utilization of this historic spawning site. Also, Yorkshire bar was chosen as study site because a good harbour is nearby on Main Duck Island.

Previous sampling has usually involved one or more over-night sets of experimental gillnet (1/2 inch to 6 inch mesh) across the bar. Relatively high numbers of mature lake trout have been caught in recent years. However, such long-duration gillnet sets are extremely destructive of important spawning stocks and can even disrupt congregating spawning fish. So in the fall of 1987 only short-duration sets for live capture were conducted on Yorkshire Bar. This gillnetting used sets composed of two panels each 50 ft by 8 ft made of green monofilament, with one panel 2 1/2-inch mesh and one panel 3-inch mesh (Table 10). These nets were set around dusk and lifted 2 to 3 hours later. The bar was netted on four separate occasions, three times in late October and once in early November (Table 10). The fish were immediately removed from the net and kept alive in well-aerated running water and were anesthetised and tagged with a yellow numbered floy tag sutured on the anterior insertion of the dorsal fin. The fish were released at site of capture. All fish were in excellent condition when released and extremely active. Detailed biological information was collected on each fish, and their spawning conditions were classified using a system based

Table 10. Yorkshire Bar lake trout spawning study 1987. Catch-per-unit-effort expressed as numbers caught per 100 m^2 of gillnets. Gillnet sets were composed to two panels each 50 ft (15.24 m) x 8 ft (2.44 m) made of green monofilament, one 2.5-(63.5-mm) and one 3.0-inch (76.2-mm) mesh. Nets were set at dusk for 2 to 3 hours duration and used to live-capture lake trout for tagging.

Date	Water temperature at 5 m	No. of net sets	CUE at depth (m)						No. of lake trout		Percent males		Percent females		
			3	5	8	10	13	17	caught	tagged	total	ripe and running (rank >5)	total	ripe and running	spent
Oct. 21	12.2	4	20.2	17.5		5.4		4.7	39	33	64.1	16.0	25.6	0.0	0.0
Oct. 26	12.2	2		18.2	2.3				38	34	65.8	20.0	31.6	0.0	0.0
Oct. 29	11.9	3		44.4	12.8		0.5		56	53	66.1	56.8	33.9	15.8	5.2
Nov. 7	10.4	3		21.5[a]					38	32	81.6	24.0	18.4	85.7	0.0
Total		12							171	152					

[a] Location west side of bar - 10.8
east side of bar - 32.3
shore of island away from bar - 16.1

on the quantity and quality of reproductive products that appeared when the abdominal region was stroked in a consistent fashion. A detailed external description of each fish was made, including observations on spawning marks. In order to reduce the stress placed on the fish and to minimize the disruption to spawning, only a limited amount of netting was conducted during 1987. A total of 19 fish were sacrificed to obtain complete biological data, including reproductive condition and fecundity.

RESULTS AND CONCLUSIONS

The distribution of lake trout on the bar was studied by depth and location. Netting at various depths along the bar indicated that the highest concentrations (expressed as the number of lake trout caught per 100 m^2 of net) of mature lake trout were in shallow water (3-5 m) (Table 10). Although large numbers were present at these depths, lake trout were also scattered along the bar, and prior to peak spawning (as inferred by spawning condition and spawning marks), large numbers were also observed on echograms congregating in deeper water 25 m outside the bar. When spawning activity appeared to peak, larger numbers congregated in shallower water, and fewer fish were taken or observed on echograms in deeper water.

Netting and transects run with an echo sounder across the bar at spawning time indicated that most fish were congregating on the east side of the bar in 5 m of water or shallower (Table 10). Rock rubble seined in the gillnets from this location was approximately 10 to 20 cm in diameter. This seems the most likely location to locate fertilized eggs, although weather did not permit this in our 1987 program. Females taken from this location were ripe and running, and it was observed that when these entangled fish were brought to the surface in nets they were often followed to the surface by large free-swimming lake trout.

The highest reproductive index for males was observed during the last week of October, while most females were ripe and running the first week of November. The greatest catches of lake trout were made during the last week of October. The water temperature during the last week of October and the first week of November ranged from 11.9 C down to 10.4 C, slightly higher than has been reported for peak spawning activity of lake trout. Since a high percentage of the lake trout caught in early November had spawning marks, it is felt that peak spawning activity on Yorkshire Bar probably occurred in very late October or very early November near the end of October, and may have coincided with full moon. Fewer lake trout were present on the bar when sampled in early November, and a high percentage of these fish had spawning marks, the males had a lower spawning condition index.

Prior to peak spawning activity rockbass, smallmouth bass, and walleye were taken on the bar, but during the peak period none of these species were present. Large congregations of spawning lake trout

probably exclude other species. Conversely, the lack of other species at spawning time may indicate high densities of cruising and even aggressive spawning lake trout. This behaviour is observed in inland lakes.

Experience in inland lakes indicates that gillnetting of spawning congregations is probably rather disruptive. Even sets of short duration which produce fish that appear to be in excellent condition and are lively when removed from the net require considerable time (in this work up to 10 to 20 minutes) before they regain equilibrium. It has been observed in inland lakes that fish tagged under these conditions move away from the spawning area. A similar observation was made during our work on Yorkshire Bar in 1987 because even though the trout recovered their equilibrium quickly and were very active when released, we did not subsequently recapture any of the tagged fish. They apparently moved away from the bar after they were released because one tagged lake trout was taken 18 days later 36 km away in a commercial gillnet set for whitefish. We observed that several of the largest lake trout tagged during the period had old gillnet wounds that had healed.

The density of lake trout on Yorkshire Bar in the fall of 1987 was substantially higher than that observed in 1984, the last year Research netting was conducted. After the 1987 catches were corrected for duration and amount of effort, it appears that there were three times as many lake trout on the bar in 1987 as in 1984, and in 1984 there had been a substantial increase over previous years (Table 11). In 1987 the lake trout were heavier, averaging 2.91 kg, as compared with 2.63 kg for the catch in 1984. When gillnet catches on Yorkshire Bar at spawning time are compared with those of midsummer in the outlet basin at the index gillnet stations, it appears that the density of fish on Yorkshire Bar showed a slight relative increase in 1983 (1.2x), a substantial increase in 1984 (3.7x), and a very significant relative increase in 1987 (5.8x).

The majority of fish taken in 1987 were in the 600-mm FL class (65%) as compared with the 500-mm FL class in 1984 (53%) (Table 12). Wounding and scarring of mature lake trout taken on Yorkshire Bar in 1987 was high, but slightly lower than that observed in the early 1980's.

A detailed analysis will be conducted on the catch and biological data on lake trout taken on Yorkshire Bar over the years. The tagging and marking study will continue to examine recurrent use of the bar and the dispersal and diminution of tagged lake trout. Spawning activity and egg deposition will be studied. The behaviour and movement of individual lake trout will be studied by using sonic tags. A systematic search for indigenous juvenile lake trout will be conducted in adjacent potential nursery habitats by using various types of nets and trawls.

One of the major problems that has developed in this study involves the inability to determine the age of most live hatchery fish that

Table 11. Lake trout catch statistics for 11 years (1975-87) for gillnets set at spawning time on Yorkshire Bar of Yorkshire Island and standard Lake Ontario experimental gillnets set at 26 to 29 m deep at six stations throughout the Outlet basin (Kingston basin) in the east end of Lake Ontario. Catches are expressed as number and weight of lake trout to 100 m^2 of net. The catches in the 2.5 and 3.0 mesh panels are expressed in the same units. The 1987 netting was conducted with a slightly different type of net composed of two mesh sizes (see Table 10).

	Yorkshire Bar spawning period									Outlet basin June-August		
	2.5-inch mesh			3.0-inch mesh			1.5 to 6.0-inch mesh experimental gillnet			1.5 to 6.0-inch mesh experimental gillnet		
	CUE			CUE			CUE			CUE		
Year	N	kg	Average wt (kg)	N	kg	Average wt (kg)	N	kg	Average wt (kg)	N	kg	Average wt (kg)
1975	0.00	0.00		0.00	0.00		0.40	0.05	1.508	0.22	0.21	0.955
1976	0.00	0.00		0.00	0.00		0.00	0.00		0.22	0.24	1.106
1977	0.44	0.51	1.129	0.11	0.02	2.222	0.47	0.78	1.646	0.41	0.35	0.957
1978	0.60	0.87	1.450	0.90	1.13	1.250	0.54	0.70	1.294	0.76	0.71	0.932
1979	0.30	0.48	1.600	0.30	0.45	1.500	0.36	0.73	2.048	0.94	1.32	1.402
1980	0.40	1.01	2.522	0.20	0.15	0.758	0.60	1.34	2.248	2.74	2.86	1.644
1981	0.79	1.09	1.376	1.99	4.20	2.108	1.21	2.95	2.426	1.77	2.27	1.279
1982	2.35	3.35	1.403	1.20	2.37	1.985	1.79	3.57	1.994	2.59	2.99	1.154
1983	3.59	8.36	2.332	4.78	10.73	2.245	4.96	12.30	2.481	4.19	6.04	1.442[a]
1984	21.51	56.60	2.631	11.95	29.16	2.440	19.84	52.11	2.626	5.38	10.38	1.929[a]
1985										6.73	13.88	2.062
1986										5.26	10.42	1.980
1987	[52.60	162.84		49.60	135.28][b]		[60.55	176.32	2.912][d]	10.49	21.59	2.059
	[13.15	40.71	3.097	12.40	33.82	2.727][c]						

[a] Estimated catch.

[b] Catch data adjusted for activity on spawning grounds to approximate the CUE for a 24-hour period to make the results generally comparable to other years.

[c] Original catch data, sets of short duration, 2-3 hours.

[d] Estimated catch calculated from previous catch relationship between 2.5-inch and 3.0-inch mesh and 1.5 to 6.0-inch mesh experimental gill net sets on Yorkshire Bar.

Table 12. Lamprey wounding and scarring of lake trout caught on Yorkshire Bar at spawning time (1975-87), separated into 100-mm FL classes.

				Wounding				Scarring			
FL class (mm)	Year	Number of lake trout	CUE[a]	Number wounded	Percent wounded	Total number of wounds	Wound index[b]	Number scarred	Percent scarred	Total number of scars	Scar index[c]
200	1975	0	0.0								
	1976	0	0.0								
	1977	1	0.2	0	0.0	0	0.00	0	0.0	0	0.00
	1978	0	0.0								
	1979	0	0.0								
	1980	0	0.0								
	1981	0	0.0								
	1982	0	0.0								
	1983	0	0.0								
	1987	0									
300	1975	0	0.0								
	1976	0	0.0								
	1977	11	2.0	0	0.0	0	0.00	1	9.1	1	0.18
	1978	4	1.5	0	0.0	0	0.00	1	25.0	1	0.38
	1979	0	0.0								
	1980	3	1.0	0	0.0	0	0.00	0	0.0	0	0.00
	1981	5	1.8	0	0.0	0	0.00	0	20.0	0	0.36
	1982	1	1.1	0	0.0	0	0.00	0	0.0	0	0.00
	1983	0	0.0								
	1984	0	0.0								
	1987	0									
400	1975	1	0.4	0	0.0	0	0.00	1	100.0	2	0.80
	1976	0	0.0								
	1977	10	1.8	0	0.0	0	0.00	0	0.0	0	0.00
	1978	21	7.7	0	0.0	0	0.00	0	0.0	0	0.00
	1979	3	1.0	0	0.0	0	0.00	0	0.0	0	0.00
	1980	6	2.0	0	0.0	0	0.00	0	0.0	0	0.00
	1981	8	2.8	1	12.5	1	0.35	1	12.5	1	0.35
	1982	8	8.9	0	0.0	0	0.00	1	12.5	1	1.11
	1983	2	2.1	0	0.0	0	0.00	0	0.0	0	0.00
	1984	2	4.3	0	0.0	0	0.00	1	50.0	1	2.15
	1987	2		0	0.0	0	0.00	0	0.0	0	0.00
500	1975	1	0.4	0	0.0	0	0.00	1	100.0	1	0.40
	1976	0	0.0								
	1977	13	2.8	0	0.0	0	0.00	8	53.3	9	1.68
	1978	7	2.6	1	14.3	1	0.37	1	14.3	1	0.37

Table 12 continued

	1979	18	6.0	3	16.7	4	1.33	4	22.2	4	1.33
	1980	12	4.0	0	0.0	0	0.00	2	16.7	2	0.67
	1981	28	9.8	1	3.6	2	0.70	6	21.4	9	3.15
	1982	14	15.6	2	14.3	2	2.23	5	35.7	10	11.14
	1983	58	60.2	4	6.9	6	6.23	26	44.8	39	40.48
	1984	81	175.8	0	0.0	0	0.00	36	44.4	54	117.21
	1987	50		2	4.0	2		15	30.0	20	
600	1975	0	0.0								
	1976	0	0.0								
	1977	2	0.4	1	50.0	1	0.20	0	0.0	0	0.00
	1978	0	0.0								
	1979	3	1.0	1	33.3	1	0.33	1	33.3	1	0.00
	1980	9	3.0	1	11.1	1	0.33	2	22.2	4	1.33
	1981	15	5.2	0	0.0	0	0.00	6	40.0	7	2.43
	1982	3	3.3	0	0.0	0	0.00	3	100.0	7	7.70
	1983	17	17.6	0	0.0	0	0.00	14	82.4	28	28.99
	1984	71	154.1	0	0.0	0	0.00	52	73.2	95	206.19
	1987	110		6	5.5	8		74	67.3	145	
700	1975	0	0.0								
	1976	0	0.0								
	1977	0	0.0								
	1978	0	0.0								
	1979	0	0.0								
	1980	0	0.0								
	1981	2	0.7	1	50.0	1	0.35	1	50.0	2	0.70
	1982	1	1.1	0	0.0	0	0.00	1	100.0	2	2.20
	1983	3	3.1	0	0.0	0	0.00	3	100.0	8	8.27
	1984	0	0.0	0	0.0	0	0.00	0	0.0	0	0.00
	1987	6		0	0.0	0	0.00	5	83.3	11	

[a] Catch of an experimental gillnet composed of ten equal length panels of mesh sizes ranging from 1.5 to 6-inch mesh in 0.5-inch intervals. In 1987 only 2.5 and 3.0-inch mesh nets were used (see Table 1).
[b] Wound index = total number of wounds/number of fish x CUE.
[c] Scar index = total number of wounds/number of fish x CUE.

are handled. The procedure of using a single external mark and a nose tag accentuates the problem. It is recommended that the procedure of applying a distinct external clip be retained along with the nose tag so that better age information can be determined without killing the fish.

Numbered floy tags are being used in this study. If any of these fish are caught by others, we request that complete biological data be collected on the fish. For further information on this tagging study and these tagged fish, please contact us at 613-476-2400.